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St. Louis Section: C. F. CARRIER, *Chairman;* H. A. CARLTON, *Secretary,* Mallinckrodt Chemical Works, St. Louis.

University of Missouri Section of the A. C. S.: A. J. HOGAN, *Chairman;* L. D. HAIGH, *Secretary,* 1617 Cauthorn Ave., Columbia.

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NEBRASKA: Nebraska Section of the A. C. S.: D. J. BROWN, *Chairman;* E. J. BOSCHULTE, *Secretary,* University of Nebraska, Lincoln.

NEVADA: Science Division of the Nevada State Teachers' Institute: G. W. SEARS, *Chairman;* E. C. STRENG, *Secretary,* 766 West Street, Reno.

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Northern Division: LORNE F. LEA, *Chairman,* St. Paul's School, Concord, New Hampshire.
Southern Division: J. W. INCE, *Chairman,* Rhode Island State College, Kingston, Rhode Island.
Western Division: E. C. WEAVER, *Chairman,* Bulkley High School, Hartford, Connecticut.

NEW HAMPSHIRE: (*See* **New England States**).

NEW JERSEY: New Jersey Science Teachers' Association: ANNIE P. HUGHES, *Chairman;* PAUL D. TSCHUDY, *Secretary,* Senior High School, Atlantic City.

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Wilhelm Ostwald

EDITOR'S OUTLOOK

AT GROSSBOTHEN, an hour's ride from Leipzig, stands in the gracious setting of a wooded park an extensive country place to which its owner, Wilhelm Ostwald, when he established his residence there in 1906, gave a name that seemed a contradiction of its peaceful natural environment, "Energie." Ostwald was then 53 years old and had just retired from the active professorship of physical chemistry at the University of Leipzig. Few commentators have failed to read into the naming of his new home the devotion of Ostwald to the tireless force which had actuated his work as an experimenter, a teacher, and an organizer of science. It may well have been a challenge to his future by a man, who, scarcely past his prime, had already laid the record of an average lifetime of much more than ordinary accomplishment and who was deliberately turning his remarkable gifts into new fields.

Wilhelm Ostwald
1853–

Ostwald received his early training in the Polish city of Riga, which was his birthplace. A diversity of interests unrelated to institutional routine retarded his progress in the preliminary schools, but after the application of a little parental moral suasion, applied himself to his work for the doctorate, which he received from the University of Dorpat at the age of twenty-three. His first post was as assistant in physics at this university, which he left in 1881 for a professorship at Riga. Here he began his work on affinity constants, and the novelty of his investigations and their results attracted the notice of Wislicenus, through whose interest Ostwald was called to Leipzig in 1887. In the science of chemistry, the year and the event are the symbol of revolution, for the establishment of the school of physical chemistry by Ostwald at Leipzig was coincident with his sponsoring of the cause of Arrhenius, who in that year pronounced the theory of electrolytic dissociation at which Ostwald had himself arrived by a different method of approach. With Arrhenius and van't Hoff he arrayed his school of thought against the empiricals who made up the world of chemistry of that day, and with the aid of the collaborators and students who flocked to his standard, his was the victory—empirical chemistry became a science.

It is difficult to relate within a narrow compass the work of Ostwald during the ensuing decade. Its remarkable variety is not to be explained by the unusual physical and mental strength that supported its volume, but bespeaks an altogether uncommon intellectual capacity for generalization and organization to account for its power in versatility. His career as a teacher was preëminent in its immediate success and its far-reaching influence. As evidence, one need but mention the names of a few of these who have been proud to claim an intellectual sonship—Beckmann, who is associated with the construction of the thermometric apparatus demanded by the new theories of measurement, Walden who

worked in Ostwald's laboratory on solvents and abnormal electrolytes, Nernst, who studied the primary cell, the solution tensions of metals, the nature of saturated solutions, and the chemistry of thermodynamic relations, and LeBlanc, who laid the foundations of electrochemistry.

Ostwald's editorship of the *Zeitschrift für physikalische Chemie*, which in association with van't Hoff and others he organized in 1887 as the mouthpiece of the Leipzig school of physical chemistry, and the first issue of which contained the papers by van't Hoff and Arrhenius which were the battle-cry of the new era, continued until the publication of its hundredth volume in 1922. In addition to his duties as editor of this invaluable repository of scientific progress, he contributed to its numbers and to his texts a vast literature covering his own investigations on the law of dilution, solution conductivity, absorption of light by solutions, the theory of indicators, the work on allotropy, valence, and catalysis.

No account of Ostwald would do justice to him without listing the textbooks through which his influence as a teacher spread. The first volume of the "Lehrbuch der Allgemeinen Chemie" appeared in his early teaching days at Riga; subsequent volumes and editions continued to come out in a rapid succession that was yet not rapid enough to keep up with the march of the science. In the "Grundlinien der Anorganischen Chemie" he advocated the logic of teaching ionic chemistry in fundamental courses. The "Physiko-Chemische Messungen" gave a unified discussion of the new physical chemical methods, many of which he had himself devised. His peculiar genius in selection was revealed to particular advantage in the "Klassiker Exakten Wissenschaften," which he planned and helped to organize, and which he edited for many years.

Of particular interest to Americans is the service Ostwald rendered science in rescuing from comparative oblivion the work of Willard Gibbs on thermodynamics. Through the translation of these papers into German, Ostwald introduced the fame of Gibbs into Europe and materially advanced the American scientist's honor in his own country.

In 1909, Ostwald was awarded the Nobel prize in chemistry "in recognition of his works on catalysis, as well as for his investigations into the fundamental principles governing chemical equilibrium and rates of reaction."

After his retirement from teaching, Ostwald continued his scientific work, but carried his amazing versatility outside the field of science. His interests have been artistic, philosophic, and social, and he makes it plain in his autobiography that he considers his services in these lines by no means inferior to his scientific achievements. Blessed with a family who recognize the just demands of genius by lifting from him the burden of material cares, he spends his latter years in the applica-

tion of his ripe experience to a multiplicity of pursuits which give him a right to the title, "a full man," if ever a man deserved it.

The Journal of Chemical Education acknowledges its indebtedness to Mr. Sederholm, managing director of Nobelstiftelsen, Stockholm, Sweden, for the accompanying photograph of Wilhelm Ostwald.

Showman and Educator

SCARCELY any one will read the article on the chemical section of the Deutsches Museum which appears elsewhere in these pages without experiencing some curiosity concerning the man who founded that famous institution and who, at the age of 75, still devotes to it a vigor and enthusiasm which might be envied by many a man of half his years. How did he come by the idea originally? How did he contrive to give it concrete form? What special qualities and experiences prepared him to succeed so signally in this great and unusual undertaking?

Such questions occur to one in passing and more often than not remain unanswered, either because of the pressure of other interests and duties, or through sheer inertia. It seemed to us a happy coincidence, therefore, that we chanced upon a sketch by Ishbell Ross in the magazine section of the Baltimore *Sunday Sun* shortly after Professor Prandtl's manuscript had been set in type.

Dr. Oskar von Miller, so the writer tells us, came of forebears who had been prominent in Bavaria for two generations. His grandfather was director of the Academy of Art in Munich; his father was a skilled worker in metals and a personality well known throughout Munich long before he cast the bronze figure in the Bavarian Ring which brought him his chief fame.

As a boy von Miller showed little aptitude for classical studies but he had a pronounced mechanical bent. His father, taking note of these facts, sent him to the Technische Hochschule to be educated in engineering. After graduation he entered the civil service and occupied a succession of posts which brought him into first-hand contact with many of the problems of his profession.

At the Electro-Technical Exposition in Paris he saw the first of Edison's incandescent lamps to be shown in Europe and became an enthusiastic believer in the future of electricity. Shortly afterward he was the leading spirit in the organization of an electrical exhibit in Munich. In 1891 he took charge of an industrial exposition at Frankfurt and no doubt learned much about the necessities of an industrial museum which later stood him in good stead.

The writer continues:

> When he first visioned his industrial museum he went to work with an immense

energy and concentration that swept aside all obstacles and made it possible for him to realize his dream, not with slow steps, but with swift, seven-league strides.

In 1903 he laid his conception before a convocation of the leading engineers, scientists, and industrialists of Germany. He pointed out to them that the principle of letting the public experiment on its own account was to be applied to the fullest extent throughout his projected museum.

His enthusiasm awakened a response. Within a year the museum was under way.

From its beginning the museum grew like magic. The rulers of the German states and municipalities, as well as manufacturers, scientists, and engineers, contributed exhibits or money. Even the building material was partly donated by industry and the unions gave their labor. Eventually, it was possible to assemble 60,000 machines, models, pictures, and other exhibits. The exhibits were so arranged that as the visitor traversed the nine miles of corridor he walked from one century of industrial progress to another, from the first wheel to the completed locomotive, from a replica of the Wright airplane to the latest type of dirigible—a sustained and fascinating record of man's mechanical success.

At first the collections were housed in the old building of the Bavarian National Museum, but in 1911 the island of Insel, in the River Isar, was presented by the city and carefully prepared plans for a large and comprehensive set of buildings were developed. They were virtually completed in 1913, but the World War delayed the actual task of removing and installing the collections. The museum was formally opened on May 6, 1925, its extensive buildings of reinforced concrete housing the most complete record in existence of the age of mechanical progress.

It is characteristic of Dr. von Miller that no new exhibit is assured of a permanent place in the museum until it has passed the test of ability to arouse public interest. The original display on nutrition was thrown out bodily and the present group substituted. The room devoted to the chemistry of digestion soon became, and still is, one of the most popular in the museum.

The ideas embodied in the Deutsches Museum have been amply justified in the minds of all who have had the privilege of visiting that famous institution. Happily they are taking root elsewhere and the beginnings of similar collections of exhibits are already springing up in America. The time should come when every great metropolis has its scientific and industrial museum. These probably would not be, and they should not be, exact duplicates of each other. The resources and activities of the regions surrounding them might well determine which fields were to receive greatest emphasis in each. Historical exhibits need not necessarily be duplicated save where they involve replicas of original machines and apparatus. In the illustration of scientific principles the ingenuity and originality of directors and their staffs might well lead to numerous different methods of presentation.

IN DISCUSSIONS of modern civilization and its problems one frequently encounters the intimation that science is non-moral—occasionally, that it is destructive of morality. Is there any basis for

Science and Morality

such a charge and, if so, how seriously should it be taken?

If morality is conceived to be a matter of taboos and fetishes there can be little doubt that science is a destructive force. However, it is well to remember that there is no intrinsic demerit in destruction: one must consider the nature of the thing destroyed. After all, the difference between construction and destruction is often a mere trick of language. Almost any idea may be phrased either positively or negatively, according to choice. Indeed one cannot affirm a truth without in effect denying the contrary untruth. If the critics of science can lay no more damaging charge than that the discoveries of science or the wider influence of the scientific attitude of mind have made some of our social mores look a bit ridiculous and outmoded, we need not be greatly disturbed by what they have to say.

Perhaps, though, we are propping up a straw man hardly capable of standing alone when we consider this possible aspect of the question at all. It might be better to eschew cynicisms and half-truths and to agree upon a more generally acceptable working definition of morality. Possibly we shall come as close to such a definition as may be if we say that morality is that mode of conduct which promotes the common good.

From this point of view it seems that the possession of good morals is not entirely a matter of good intentions. It is necessary to be well informed in addition to being well disposed. This idea, we believe, might reasonably be construed as lending support to the thesis that science is friendly rather than inimical or neutral to morality. For science has taught us a great deal about the manner in which our conduct affects the common good. We no longer consider it moral to locate a cess-pool where it will contaminate a neighbor's well, or to permit a typhoid carrier to handle food products. A hundred years ago we were unaware that such offenses existed. Three hundred years ago we hung witches for exercising the baleful powers of the evil eye.

Furthermore, one may reasonably maintain that science encourages to some extent the disposition to act ethically. For, as Huxley and others, before and since, have remarked, science demonstrates the general principle that in the long run the individual best serves his own interests by acting in promotion of the common good. And certainly science has confirmed rather than contradicted the warning that "the wages of sin is death."

It may be objected that to appeal to self-interest or to the fear of punishment is to place motivation upon a low plane. Yet religion, always the champion of morality, has never disdained to employ these appeals. The chief difference is that, whereas religion promises rewards and punishments in a hypothetical hereafter, science promises them more or less immediately, and is able to point her promises with numerous concrete object lessons.

THE DIALYZER

1. Who was mainly responsible for transforming chemistry from an empirical system to a science? (pp. 730–3, 927.)

(*For questions* 2–5 *see* pp. 737–61.)

2. How old is the potash industry in the United States?
3. Where is the principal productive source of potash in America? Is the supply sufficient for domestic needs?
4. Name the chief potash-bearing minerals. Are they colored?
5. What is alunite?

(*For questions* 6–8 *see* pp. 762–81, 733–4.)

6. When was the "*Deutsches Museum*" founded? By whom?
7. Name four chemical books written in the 16th century.
8. What four men are responsible for the chemical thought of the first half of the 19th century?

(*For questions* 9–10 *see* pp. 782–93.)

9. In the light of the modern conception of acids and bases, how would you define neutralization?
10. Acids are classified by two properties—(1) strength and (2) charge type. Explain.

(*For questions* 11–13 *see* pp. 794–811.)

11. What conditions are necessary for the development of the seeds and pods of the peanut?
12. For planting, are shelled or whole peanuts used?
13. Do peanut plants suffer from ravages of any pests?
14. In memory of what chemist, an authority on rare earths, was a new chemical laboratory recently dedicated? (pp. 812–20.)
15. Name 17 institutions which have erected new chemical laboratories within the past ten years. (pp. 821–7.)
16. What place in chemical education have motion pictures? (pp. 828–33.)
17. How may structure symbols be used effectively in organic chemistry? (pp. 836–41.)
18. How has the introductory chemistry course at one of our leading universities been adapted to the interests of the chemical engineers? (pp. 842–4.)
19. Are you looking for a new prep for your organic chemistry class? (pp. 856–8.)
20. What Faraday tradition has recently been disproved? (p. 859.)
21. Why does the Bragg X-ray pattern for KCl differ from that for NaCl, whereas the Laue patterns for the two crystals are similar? (pp. 860–72.)
22. What well-known organic chemical has been found especially effective in preserving museum exhibits and works of art from the ravages of tropical molds? (pp. 873–81.)

(*For questions* 23–24 *see* pp. 882–90.)

23. What qualities must a practical fixing solution have, aside from the ability to remove silver halides from the film?
24. What factors determine the rate and efficiency of washing of photographic plates and films?
25. The January JOURNAL contained a method for calculating crystal dimensions (pp. 147–8). What other method of calculation based on essentially the same data, but employing different terms, is possible? (p. 907.)
26. How may a teacher's professional needs be financed? (pp. 913–6.)
27. What were the most important chemical developments in 1929? (p. 924.)
28. How are the freshmen at Lehigh investing their laboratory deposit fees? (p. 943.)
29. Do you desire information concerning any of the periodicals abstracted by THIS JOURNAL? (pp. 957–70.)

POTASH IN THE UNITED STATES[1]

GEORGE R. MANSFIELD, GEOLOGICAL SURVEY, U. S. DEPARTMENT OF THE INTERIOR, WASHINGTON, D. C.

Potash—Name and Uses

The name potash is derived from "pot ashes," an impure mixture of potassium carbonate and other salts, formerly obtained by leaching wood ashes and evaporating the solution to dryness. As now used the name is applied to the theoretical oxide, K_2O, which is made the basis of all trade in salts containing potassium. K_2O itself, however, is not found in nature or manufactured in commerce.

Potash (K_2O), through its many compounds, is one of the soil ingredients necessary to plant life. It is naturally supplied to soils by the slow decomposition of grains of feldspar and other minerals, but the extensive growth of crops in agriculture removes potash from the soils more rapidly than it can be supplied by natural agencies and causes depletion, which must be remedied by artificial means if soil fertility is to be maintained. Potash is therefore a prime constituent of most fertilizers and, of all the potash-bearing materials imported into this country or manufactured here, about 95 per cent is used for this purpose.[2] Small amounts of potash are also essential for a number of chemical industries such as tanning, dyeing, metallurgy, electroplating, photography, medicinal, and miscellaneous chemical uses, and in the manufacture of soap, glass, matches, and explosives.

Consumption in the United States

According to Bureau of Mines figures for 1928, the latest available, the total quantity of domestic potash sold and of foreign potash imported for consumption during that year was about 390,000 short tons of K_2O, valued at about $25,550,000. Of this total about 15 per cent by weight and 12 per cent by value was produced in this country.

Domestic Production

Production of potash in the United States in 1928, according to the Bureau of Mines, amounted to 104,129 short tons of salts containing 59,910 short tons of K_2O. The American Potash and Chemical Corporation, the chief American producer of potassium salts, also recovered borax and other natural sodium salts as by-products from its plant at Trona (Searles Lake), California, which utilizes natural brines. In 1927 the K_2O equivalent of its product, which is marketed as the chloride, KCl, reached the unusually high figure of 60.14 per cent.[3] The K_2O equivalent of chemically pure

[1] Published by permission of the Acting Director of the U. S. Geological Survey.

[2] A. T. Coons, "Potash in 1927," U. S. Bur. Mines, Min. Res. of the United States 1927, Pt. II, 1928, p. 47.

[3] A. T. Coons, *op. cit.*, p. 44.

KCl is 63.14 per cent. The United States Industrial Chemical Co., Baltimore, Md., was the second largest producer. The salts produced by this company in 1927 were mixtures of sulfates, chlorides, and small amounts of carbonates recovered from the waste from molasses distillation. The average K_2O content was 34 per cent. Potassium salts, chiefly sulfates, were produced and sold at two of the blast furnaces of the Carnegie Steel Co., Pittsburgh, Pennsylvania. A small amount of alunite, a hydrous sulfate of potash and alumina, was shipped from Utah and used for experimental tests, a small output of potash alum was made from glauconite (greensand marl) obtained in Delaware, and a small quantity of potassium salts was produced by a sugar company in Michigan from Steffens waste water, a by-product of the manufacture of beet sugar.

Foreign Supplies

The bulk of the potassium salts used in this country is imported from Germany and France under conditions which practically constitute monopolistic control of the potash market and enable them to establish the prices at which potassium salts may be sold in the United States and throughout the world. Deposits of natural potassium salts are known in Spain, Poland, Russia, and other countries. Supplies are said to be large and some of the deposits are being worked but as yet, with the possible exception of the Polish salts,[4] they do not appreciably affect world markets for potash.

Historical Review

The potash industry in the United States probably began in the early days of the country.[5] Notice of it was taken in census statistics as far back as 1850, when the value of the product amounted to $1,402,533. The potash was obtained by leaching wood ashes. From that date onward the industry declined steadily, especially after 1890, as cheap foreign potash came more into use, practically displacing the domestic product. Meanwhile the uses for potash and the demand in this country had greatly increased.

Germany controlled the only great natural deposits of potash then known and thus became virtually the single source of potash for the world. In 1910 the German Government passed a law, which among other regulations had the effect of invalidating existing American contracts and of sharply advancing prices of potash to American consumers. This action stimulated the United States Government to undertake a systematic search for sources of commercial potash in this country and this search has continued

[4] See "Poland—a Country with a Chemical Future," N. E. Gordon, THIS JOURNAL, 4, 1394 (Nov., 1927).

[5] See "Historical Notes upon the Domestic Potash Industry in Early Colonial and Later Times," C. A. Browne, *Ibid.*, 3, 749–56 (July, 1926).

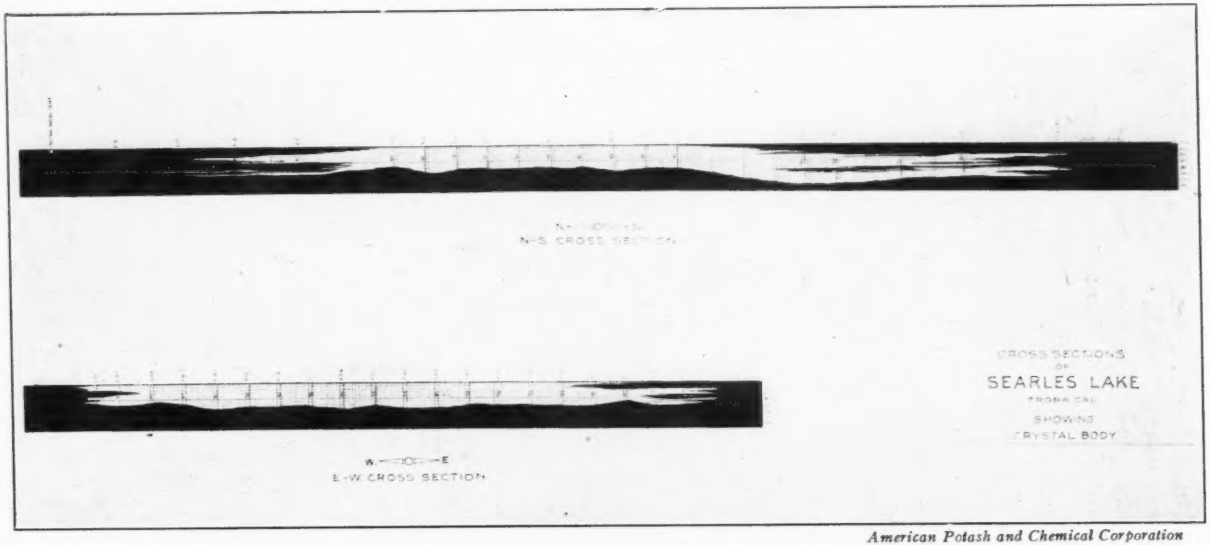
ever since. In 1911 under Congressional appropriations the Geological Survey and the Bureau of Soils began coöperative but independent investigations. Their researches covered a wide field of possible sources and the results were published from time to time by the two Bureaus.

With the shutting out of German supplies during the World War the production of potash in the United States became a grave national problem and practically all sources disclosed by the investigations just mentioned were utilized. In 1915 a total of 1090 tons of K_2O was produced in this country by five plants. Under the stimulus of urgent demand and high prices the industry moved rapidly forward and in 1918 a maximum production of 54,803 tons of K_2O was obtained by 128 plants. The nature of the price stimulus may be realized from the fact that the 1914 net price for 80 per cent muriate was about $33 per short ton. In December, 1915, as a result of the German embargo, it had climbed to $500 per ton. During the war years it averaged from $245 to $415. The signing of the armistice checked the advance of the industry and as a result of the lower prices since obtainable, plant after plant has had to close. A few plants which produce other marketable products, or in which potash is produced as a by-product, have survived. The low point in production was reached in 1921 when it amounted to only 10,171 short tons. Since then production has risen rather steadily until in 1928 it passed the 1918 figure and reached the new high point of 59,910 tons of K_2O already mentioned.

Developments at Searles Lake

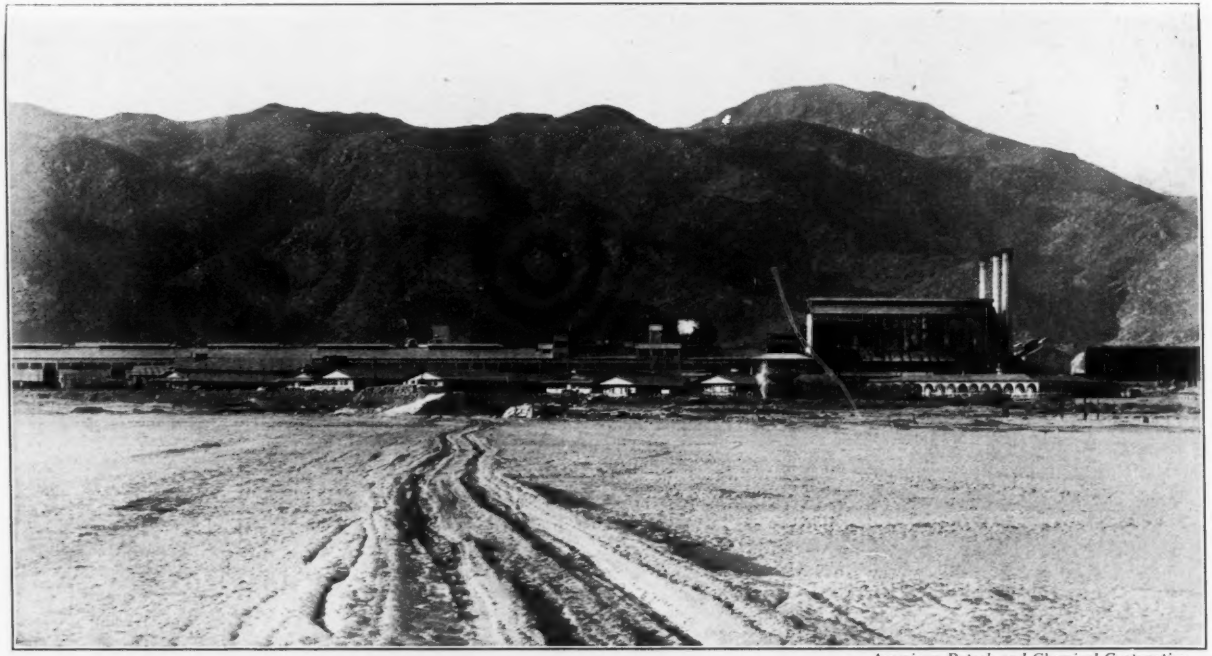
The principal productive source of American potash today is Searles Lake, San Bernardino County, California. The interesting geological, chemical, and mineralogical features of this lake have been described by Gale.[6] The lake in reality is a broad, flat, salt-incrusted surface that occupies part of a desert basin and is generally dry except when it is intermittently flooded by shallow water. It is chiefly distinguished by a mass of crystalline salts with an exposed surface estimated at 11 or 12 square miles but extending unknown distances beneath the adjoining, locally treacherous, playa muds and soils of the basin. (See Plate I.) The thickness of the salt is reported to average 70 to 75 feet in the main part of the deposit. The salt cake is largely composed of crystalline halite with a surface hard enough to support heavy machinery. In fact a road and narrow gage railroad have been built on it from the shore to a pumping station several miles out. Within the salt mass below the surface the texture is open enough to allow relatively free movement of the heavy, saturated brine, which normally stands within a few inches of the surface. During the World War several plants at Searles Lake succeeded in producing

[6] H. S. Gale, "Salines in the Owens, Searles, and Panamint Basins, Southeastern California," *U. S. Geol. Survey Bull.* **580,** 265–312 (1914).



American Potash and Chemical Corporation

PLATE I.—DIAGRAM SHOWING CRYSTALLINE SALT BODY AND ADJOINING MUDS AT SEARLES LAKE, CALIFORNIA. NOTE INTERFINGERING RELATIONSHIP



American Potash and Chemical Corporation

PLATE II.—PLANT OF AMERICAN POTASH AND CHEMICAL CORPORATION, SEARLES LAKE, CALIFORNIA
View northwest from surface of salt body (foreground), with Argus Range in background.

from the brine potash which was marketed, but all save that of the American Trona Corporation were eventually forced to close and even this plant was shut down for some months during new installations necessitated by experimental work. The success of this organization (now the American Potash and Chemical Corporation) in gaining a place in the present highly competitive potash market is largely due to the genius of J. E. Teeple, the chemist selected for the task, and to the high quality of the products which he and his associates succeeded in obtaining. (See Plate II.)

Two other companies have been engaged for several years in experimental work at Searles Lake, but as yet have not attained commercial production.

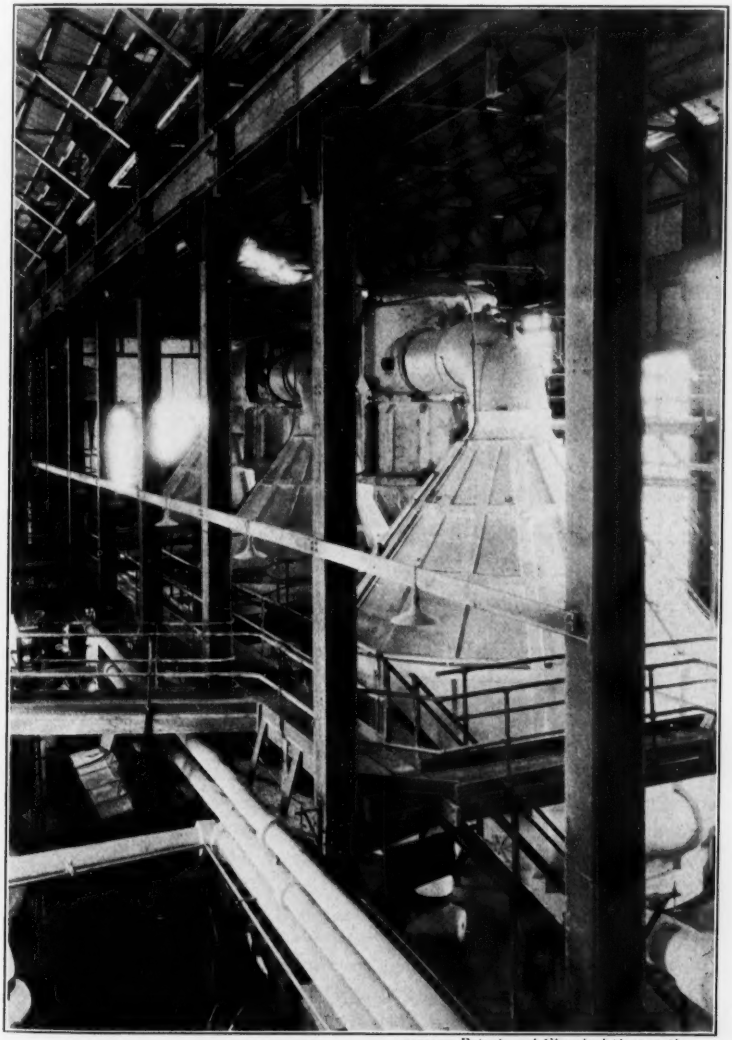
The story of the development and operation of the American Potash and Chemical Corporation's plant at Searles Lake as told by Teeple[7] makes interesting reading, but it cannot be entered into here in any detail. Suffice it to say that from 1919, when the success of the project hung in the balance as "only a fair bet," to 1929, when the operation includes "by far the largest borax plant in the world, and one of the largest potash plants," many difficulties had to be overcome step by step through painstaking research. "The corporation is producing and marketing today between 20 and 25 per cent of all the potash used in America.... It is making and marketing nearly half the borax and a considerable per cent of the boric acid that the whole world uses." The daily capacity of the plant, which is in two units, is about 250 tons of potassium chloride and 125 tons of borax, some of the borax being afterward converted into boric acid.

Teeple, referring to his company, said in 1926: "This immense production of potash has removed all danger that the United States may ever suffer from a potash famine.... In time of stress it would be easily possible within a year to build plants on this one lake that would supply all the potash that we need. We are now using only 250,000 to 300,000 tons of K_2O a year. We could probably use two or three times that much to good advantage.... With proper education of the consumer in the use of potash our imports of it from Germany and France should increase rather than decrease for years to come."

This prediction has already received partial fulfilment in the fact above noted that consumption of potash in the United States in 1928 amounted to about 390,000 short tons of K_2O, whereas in 1926 it was approximately 290,000 tons. Moreover, in 1928 the increase in gross weight of imports of potash for consumption was 33.5 per cent as compared with 1927.

Some of the evaporating machinery of this interesting plant is shown in

[7] J. E. Teeple, "The Industrial Development of Searles Lake Brines with Equilibrium Data," *Am. Chem. Soc. Mon. Ser.* No. 49, New York, 1929. See also his address delivered at the meeting of the Institute of Politics at Williamstown, Mass., Aug. 12, 1926, published by the Nat. Fertilizer Assoc., 1926.



American Potash and Chemical Corporation

PLATE III.—ONE OF THE TRIPLE EFFECT EVAPORATOR UNITS IN THE PLANT OF THE AMERICAN POTASH AND CHEMICAL CORPORATION, SHOWING THE VAPOR CHAMBERS AND VAPOR LINES OF THE 22-FEET DIAMETER EVAPORATORS

American Potash and Chemical Corporation

PLATE IV.—TONS OF POTASH (95 TO 99 PER CENT KCl) AWAITING SHIPMENT, SEARLES LAKE, CALIFORNIA

Plate III. Plates IV and V show manufactured potash and borax in store-houses awaiting shipment.

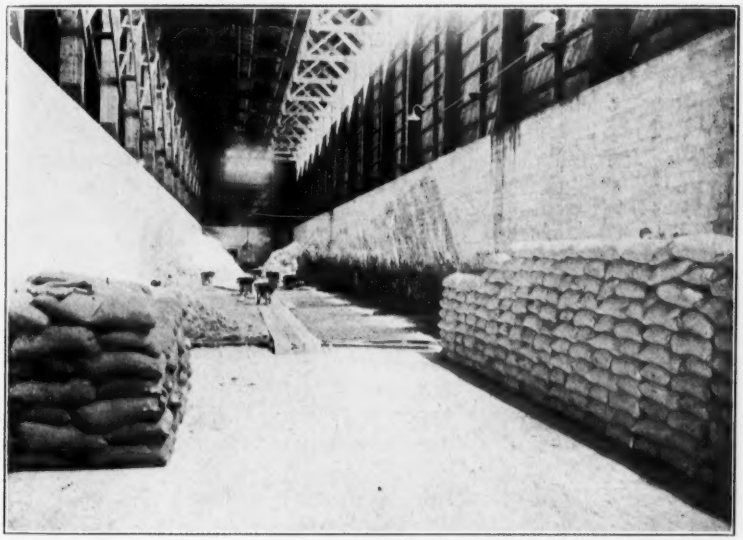
Other Sources

Both the potash and the borax markets are highly competitive. The fact that plants located at Searles Lake must make and sell borax as well as potash places some limitation on developments there. Meanwhile the control of the world's markets for potash by a foreign monopoly and the discrepancy between the amounts of potash produced and consumed in this country continue to furnish powerful incentives for starting other potash enterprises on American soil.

Space will not permit a discussion of all the possible sources of potash that have been investigated in this country. Among those that have recently been in the public mind are the following: the eastern salt-producing areas, greensand marl (chiefly New Jersey), the Permian salt basin, the Great Salt Lake desert, Wyoming leucite, and Utah alunite. These are described briefly in the order named.

Eastern Salt-Producing Areas

The great salt-producing centers of the United States, notably those in New York, Ohio, Michigan, West Virginia, and Louisiana, are all rela-



American Potash and Chemical Corporation

PLATE V.—BORAX SACKED AND READY FOR DELIVERY, SEARLES LAKE, CALIFORNIA

tively accessible to areas where large quantities of potash are consumed in fertilizers. The question is therefore occasionally asked why these salt-bearing areas are not investigated rather than western sources so much more remote from markets. Those who thus ask cannot have followed the course of potash exploration very closely, for these salt-bearing areas were among the very first to be investigated as possible sources of potash.

In 1911 and 1912 members of the Geological Survey and Bureau of Soils examined the salt plants east of the Rocky Mountains and obtained samples of the salts, brines (both natural and artificial), and bitterns utilized at these plants. Numerous well logs were also obtained and the available geological evidence was studied. Many analyses were made.[8] The results of these investigations, though not conclusive, were disappointing so far as the finding of sources of potash was concerned. Though some salt samples yielded small amounts of potash, no potash-bearing minerals were recognized. Small amounts of potash were recorded in many brine analyses, but these brines, except some that were artificially concentrated, were all much more dilute than that of Searles Lake or some of the other western brines.

The more soluble potash minerals, such as sylvite (KCl) and carnallite

[8] W. C. Phalen, "Salt Resources of the United States," *U. S. Geological Survey Bulletin* **669**, 210–49 (1919).

($KCl{\cdot}MgCl_2 + 6H_2O$), would probably be dissolved in ordinary drilling operations and not show themselves in well cuttings or even in cores unless special protective drilling solutions were employed. They would scarcely escape detection, however, in actual mining operations, such as those that have been undertaken at a number of these salt-producing localities. Polyhalite ($2CaSO_4{\cdot}MgSO_4{\cdot}K_2SO_4 + 2H_2O$), on the other hand, being less soluble, would almost certainly have been discovered in drill cuttings or cores had it been present. Although traces of potash minerals have been reported from the New York salt-producing area,[9] the general absence of any indications of these minerals in the eastern salt beds suggests that conditions of deposition when they were laid down were on the whole unfavorable for the accumulation of potash salts. It is therefore unlikely that commercial quantities of potash will be found in them. Further work on the eastern salt beds has accordingly been abandoned at least until certain other deposits, apparently more favorable for the production of soluble potash salts, have been investigated.

Greensand Marl

The potash content of greensand marl is relatively low, about six to eight per cent, but greensand is so accessible to transportation and to markets, so easily minable by steam-shovel methods, and so susceptible to extraction that its exploitation offers attractive possibilities. During the World War many attempts were made to produce potash from greensand and one of them had made considerable headway by the time the armistice was signed. This was the Charlton process, which, as elaborated by Shreve,[10] employs lime and water with greensand in a digester at a temperature of about 470 degrees Fahrenheit and under a pressure somewhat over 500 pounds. The chief reaction that takes place is that of lime on greensand, which on the one hand liberates potash in a very pure caustic form and on the other produces a material high in lime with valuable cementitious and liming properties.

Later research on the utilization of greensand has been conducted by the Bureau of Soils and independently along similar lines by A. J. Moxham at Odessa, Del. By the Moxham process, according to Turrentine,[11] greensand without preliminary treatment is mixed with hot, dilute sulfuric acid. The reaction starts at a temperature of about 85 to 90 degrees centigrade, obtained merely by the dilution of the acid with water and the

[9] H. L. Alling, "The Geology and Origin of the Silurian Salts of New York State," N. Y. State Museum *Bulletin* **275**, 89, 92, 103 (1928).

[10] R. N. Shreve, "The Action of Lime on Greensand," *J. Ind. Eng. Chem.*, **13**, 693 (Aug., 1921).

[11] J. W. Turrentine, "Potash from Greensand (Glauconite)," *Ind. Eng. Chem.*, **17**, 1177–81 (Nov., 1925).

heat of the reaction of the acid on the greensand, and is complete within five or six hours. The resulting materials are iron oxide, ochers, alum, aluminum sulfate, alumina, potassium sulfate, "glaucosil," and fuming or other sulfuric acids. Glaucosil, the granular siliceous residue from the original acid treatment of the greensand, possesses highly adsorptive qualities which would render it useful as a decolorizing and purifying agent.

Thoenen[12] has recently thrown considerable light on the commercial feasibility of these processes by means of cost studies involving the economics of producing and marketing a variety of suggested products of greensand. His results do not justify optimism but they do not exclude the possibility of profitable operation. Especially significant are his findings that foreign potash fertilizer products can be distributed at many seaboard and interior points at lower freight rates than similar products from New Jersey and that the expansion of existing experimental processes to supply the country's needs with respect to potash would be checked by the difficulty of marketing the resulting by-products.

Permian Salt Basin

The Permian salt basin extends from central Kansas southwestward through the panhandle section of Oklahoma and Texas into southeastern New Mexico and southwest Texas. The great accumulations of salt here and the general geological similarity of this basin to the potash-bearing salt basins of Germany and Alsace early attracted the attention of geologists and led to the hope that commercial beds of potash might ultimately be found in this region. Udden's discovery of potash in brine from a well in Dickens County, Texas, in 1912 was followed by coöperative investigations by State and Federal Geological Surveys, and later, when the State Survey was forced to withdraw because of lack of funds, by the Federal Survey alone.

The investigation consisted chiefly in following wildcat drilling developments in territory supposed to be underlain by Permian salt beds, securing samples of the salts penetrated and analyzing the samples thus obtained. The coöperation of the drilling companies was necessary to the prosecution of the work and was usually freely accorded though the interests of the drillers were generally in oil rather than in potash. The Government itself drilled a test well in Potter County in 1916. Although this well was located between two wells relatively nearby, each of which had shown evidence of the presence of potash, it proved practically barren. The first actual potash mineral recognized was polyhalite ($2CaSO_4 \cdot MgSO_4 \cdot K_2SO_4 + 2H_2O$). It was discovered in well cuttings from Midland and Dawson counties, Texas, and its identification was announced by the Geological Survey in June, 1921. Somewhat later the mineral sylvite (KCl) was

[12] J. R. Thoenen, "Potash from New Jersey Greensand, Preliminary Report," Dept. Commerce, Bur. Mines, *Reports of Investigations* No. 2910 (Feb., 1929).

recognized in cuttings from a well in Eddy County, New Mexico. With successive discoveries, chiefly of polyhalite, public interest in the exploration became so widespread that a law was passed (Public No. 424—69th Cong., approved June 25, 1926) authorizing an annual appropriation of $100,000 for a period of five years for joint potash investigations by the Departments of the Interior and of Commerce. Drilling operations were specifically provided for, but under conditions which made it difficult to carry out the intent of the law. These objectionable provisions were ameliorated by subsequent amendment (Public No. 759—69th Cong., approved Mar. 3, 1927).

The Geological Survey, representing the Department of the Interior, and the Bureau of Mines, representing the Department of Commerce, have thus been carrying on a campaign of core drilling in Texas and New Mexico, which is now well advanced in its fourth year. The Geological Survey is selecting the drilling sites, making the necessary analyses and tests, and announcing the findings relating to potash. The Bureau of Mines is handling the necessary contracts, conducting the drilling operations, and undertaking technological investigations to devise methods of mining, extraction, and refinement of potash salts.

Fifteen holes have already been completed and one is now drilling (January, 1930). Six are in New Mexico (five in Eddy County and one in Lea County) and nine in Texas (one each in Ector, Crane, Winkler, Reagan, and Glasscock counties and two each in Upton and Crockett counties). Figure 1 shows the distribution of the Government core tests as well as some areas drilled by private companies. Two additional drilling sites, one in New Mexico and one in Texas, have already been selected. Twelve of the cores have been studied and reported in the public press.

In addition to the coring done by the Government several oil companies have made core tests for potash in connection with their search for oil, and two companies, one operating in New Mexico and the other in Texas, have made core tests with special reference to the possibilities of exploiting the potash commercially. To date (January, 1930) twenty-two such core tests have been made in New Mexico, two in Texas, and one in Kansas. These, together with fifteen Government tests already drilled, make a total of forty for the Permian basin as a whole.

The cores reveal many interesting mineralogical relationships. Six potash minerals found in the German and Alsatian potash fields have been recognized in them. These are polyhalite (several colors and textures), sylvite, carnallite, kainite, langbeinite, and leonite. Besides these several related salts common in the European potash fields, particularly kieserite and magnesite, have already been found together with anhydrite and halite, which are omnipresent. The finding of these minerals strengthens the

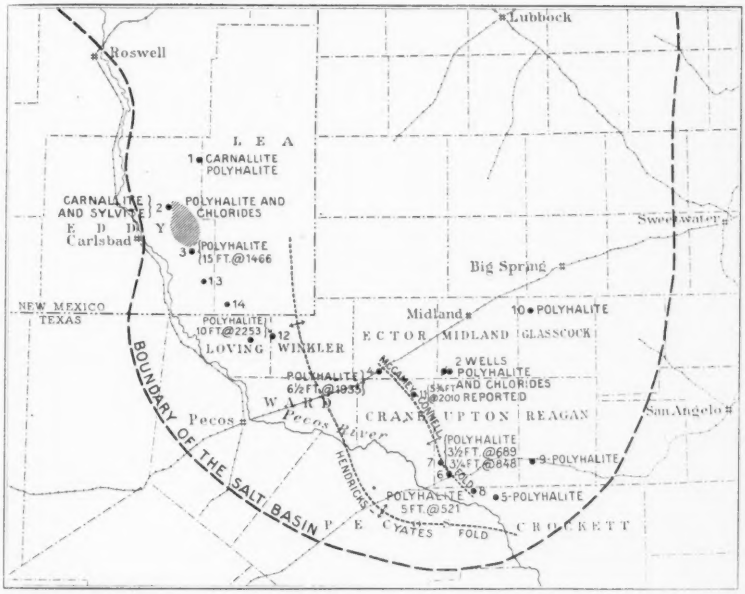


FIGURE 1.—TEXAS-NEW MEXICO POTASH AREA, SHOWING LOCATION AND RESULTS OF GOVERNMENT CORE TESTS

geologic resemblance already noted between the Permian salt basin of Texas and New Mexico and the German and Alsatian potash fields.

Polyhalite in beds, blebs, and disseminated masses is the most abundant of the potash minerals thus far recognized. Substantial bodies of this mineral, of grade comparable with salts mined abroad, or better, have been found at several localities in New Mexico and Texas. Four of these have already been announced. This mineral is less soluble than sylvite and will require more expensive technological treatment to produce the higher grade salts, though its final product (K_2SO_4) at present commands a higher price than that of sylvite (KCl). In any event these deposits form a very valuable reserve for future if not immediate use.

Work chiefly by private companies in New Mexico indicates that large bodies of the more acceptable chloride salt, sylvite, are present in that State and that they are thick enough, rich enough, and sufficiently shallow to justify extensive mining operations if transportation and marketing problems can be successfully solved. Similar salts have been reported by a private company in Texas, but little is yet known of their character and extent.

The accompanying color plates show something of the nature and relationships of the more common potash-bearing minerals and their associates,

Description of Plate VI

A. Sylvite

Top part chiefly grayish white, translucent; lower part red (colored by fine crystals of hematite) with a few inclusions of halite; streaks of the red variety penetrate the grayish white variety.

B. Sylvinite

Mixture of sylvite (red) and halite (colorless—gray by reflected light).

C. Blebby Salt

Moss-like growths of polyhalite have invaded and replaced halite.

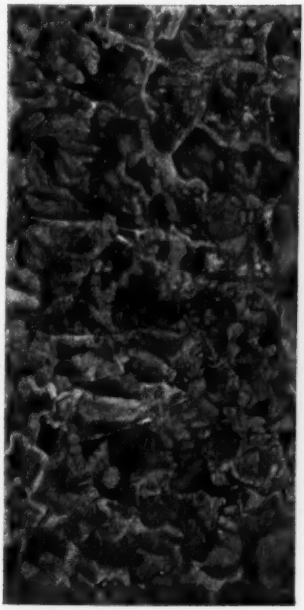
D. Polyhalite

More advanced stage of process shown by C; coalescence of polyhalite growths into fibrous mass with included blebs of halite.

A

B

C



D

PLATE VI

Description of Plate VII

A. White Polyhalite

Its markings denote various stages in its process of formation.

B. Polyhalite and Anhydrite

Salmon-colored masses of polyhalite now occupy space formerly filled by halite, which in turn had replaced earlier formed twin crystals of gypsum that had grown in anhydrite. The form of the original gypsum crystals (swallow-tail twins) is now roughly preserved in polyhalite.

C. Polyhalite and Anhydrite

Small rounded masses of salmon-colored polyhalite have grown at the expense of anhydrite and have in part coalesced into a large mass of pure polyhalite.

D. Pure Polyhalite

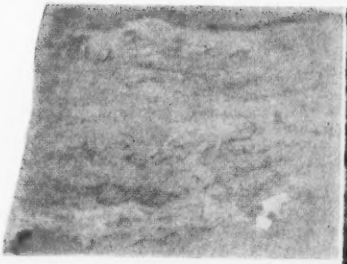
Formed as an end-product of processes indicated by B and C (complete replacement).

E. Anhydrite

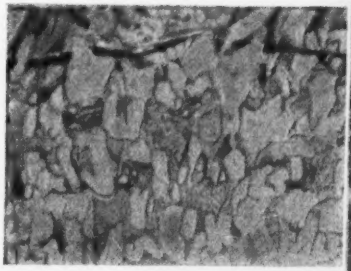
Originally marked by white horizontal bands of magnesite, it has been invaded by successive solutions, which have produced corresponding changes: first, twin crystals of gypsum were formed in anhydrite; next, these were replaced by halite, which in turn has been partly replaced by polyhalite. Horizontal polyhalite bands have also been formed.

F. Polyhalite and Anhydrite

The originally even white bands of magnesite in the anhydrite have been disrupted and displaced by the growth of spherulites of polyhalite in the anhydrite, thus giving a crinkled appearance.

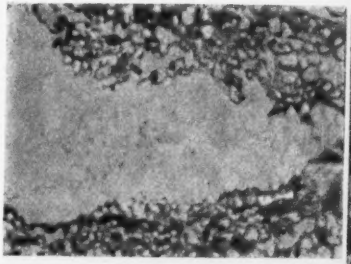


A



B

E→



C

F→

D

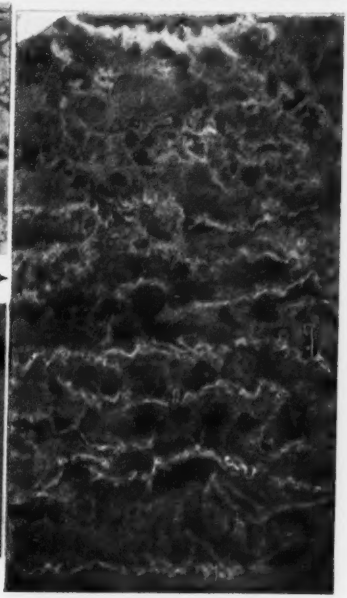


PLATE VII

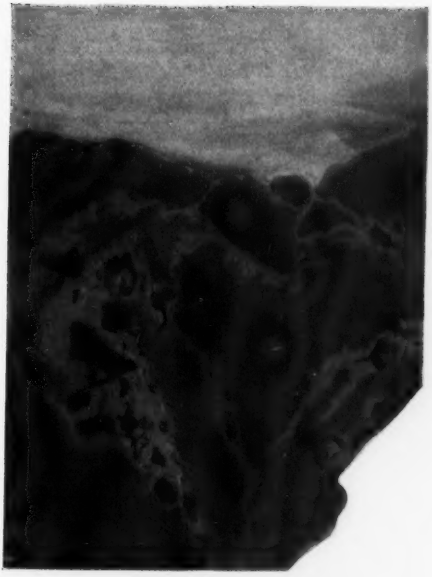
Description of Plate VIII

A. Polyhalite and Anhydrite

Cauliflower-like masses of polyhalite (brown) in at least two generations have grown into anhydrite (brownish gray). A few blebs of halite are included in the polyhalite.

B. Pinkish Langbeinite

In massive crystalline form with a little halite and clay (bluish masses). Specimen not polished.



A

B

PLATE VIII

as revealed in the cores from the Permian salt basin. The following account is kindly furnished by Dr. W. T. Schaller. The specimens are reproduced as far as practicable in natural size and color.

The potash-bearing minerals are generally colored an attractive brownish red, due to included microscopic crystals of reddish iron oxide (hematite). Occasionally a potash-free mineral, like halite or common rock salt, is similarly colored, and occasionally, too, a potash-bearing mineral will be white if no coloring pigment is present. The two minerals likely to prove of greatest commercial value are sylvite and polyhalite.

In Plate VI two specimens of sylvite, the chloride of potassium, are shown at the top. *A* is nearly pure sylvite, grayish white at the top and brownish red at the bottom, with similarly colored streaks running up into the grayish white variety. A little halite and a few scattered grains of clay are present in the brownish red variety. Such material represents the most valuable of any of the potash minerals found and will assay very close to the theoretical K_2O content. *B* represents the more abundant mixture of halite and sylvite—called sylvinite—the halite being colorless (reproduced dark gray on account of reflection of light) and the sylvite brownish red. The light-colored area along the left side of the specimen is an etched part of the core that was not polished. Material such as that represented by this specimen would have to be refined and the sodium chloride removed to produce the higher grade commercial potassium chloride.

In *C*, Plate VI, are shown mosslike growths of polyhalite (brownish red) forming in halite (rock salt). Such an association is called "blebby salt" and is very abundant, the relative quantity of polyhalite varying greatly. If conditions were such that the formation of the polyhalite in the halite continued for some time, then a solid mass of almost pure polyhalite, with only small masses of residual halite, would be formed as shown in *D*. Material such as this would be commercially valuable if found in quantity, for the halite present could readily be washed out. The polyhalite has grown in the halite as small spherulites whose coalescence has formed compact masses of fibrous polyhalite.

Polyhalite occurs in many different forms and varies in color from white to various shades and tints of orange and red. Much of it is brick-red. It is massive and compact and forms fine-grained material, fibers, spherulites, and well-developed, though small, distinct crystals. Microscopic studies have shown that much of it has been formed by the action of brines containing potassium on pre-existing saline minerals. Evidence of its formation by reaction on and replacement of anhydrite, kieserite, leonite, and halite is very abundant.

Several of the various colors and structures of polyhalite are shown in the first column of Plate VII. In *A* is the white polyhalite, which is thick enough in some places to be minable and in addition may prove to be a valuable geological horizon marker. In *B*, the salmon-colored polyhalite has the form of gypsum twin crystals. Quite a number of mineral changes have taken place to yield the final structure shown. From a study of this specimen and many other similar ones, it is evident that previous to the formation of the polyhalite, the rock was composed essentially of anhydrite, calcium sulfate, in which grew twinned gypsum crystals, in a more or less vertical position. These gypsum crystals were later dissolved and the cavities thus formed were then filled with halite, in which, at a still later stage, small spherulites of polyhalite grew. These increased in number and finally coalesced into a solid mass of polyhalite, as shown in *B*. In this specimen almost no halite remains but the shape and form of the earlier gypsum crystals are still preserved.

In *C* a number of pink spherulites of polyhalite have grown in gray anhydrite. If these had been sufficiently abundant to coalesce into a solid mass they would have formed pure polyhalite, a typical example of which, of a more brick-red color, is shown in *D*.

Many of the stages which have occurred in the formation of these saline minerals are represented in *E*. The original rock was all gray anhydrite with very narrow nearly horizontal bands of white magnesite. Resting on these magnesite bands are the vertical growths of halite (after gypsum). The specimen shown in *E* illustrates all these features. In addition, many of the vertical halite growths are colored reddish by later polyhalite, which has developed as spherulites both in the halite and in the remaining anhydrite (as shown in *C*). The specimen *E* also shows several thin horizontal layers of almost pure reddish polyhalite. If the incoming polyhalite had continued its growth, a mass of the pure mineral, as shown in *D*, would have been formed. *F* shows gray anhydrite, in which many reddish spherulites of polyhalite have accumulated. Their growth has disturbed the white magnesite bands, originally nearly horizontal, so that the continuity of these bands has been broken. The specimen has therefore acquired a crinkly appearance.

In Plate VIII, *A* represents a mass of dark brownish red polyhalite developed in anhydrite (upper part of specimen). The contact between the two minerals shows that the polyhalite has grown as cloud-like or cauliflower-like masses, which, where present in sufficient quantity, have coalesced into a solid mass of pure mineral. The light and dark areas of polyhalite suggest that its growth took place in at least two different stages. Some halite is also present. *B* is a specimen of nearly pure langbeinite, $K_2SO_4{\cdot}2MgSO_4$, partly colored pinkish by a little iron oxide. A little halite and clay are present. Upon exposure to the air langbeinite slowly takes on a dead, whitish appearance. Langbeinite may prove to be, at least locally, one of the commercially important potash-bearing minerals but it is less abundant than polyhalite or sylvite.

The Texas and New Mexico field, though large (comprising some 40,000 square miles in 22 counties), is as a whole far from existing fertilizer markets and centers of consumption. For practical purposes its output may be considered as coming from a single source, whereas foreign potash arriving by cheap water-borne freight at Atlantic, Gulf, Mississippi River, or lake ports, may be considered as available at many sources in this country. Thus, as shown by Thoenen for the New Jersey greensand, freight differentials at points of consumption are likely to favor foreign potash rather than the Texas or New Mexico product. It is probable therefore that this product, like that of Searles Lake or New Jersey, may find a restricted market, which may control its quantity and render it unable, at price levels now considered normal, to supply more than a fraction of the needs of the entire country.

Great Salt Lake Desert

The desert west and southwest of Great Salt Lake, Utah, contains two exposed salt bodies and is underlaid by brines that are unusually simple in composition, consisting chiefly of the chlorides of sodium, magnesium, and potassium. The larger salt body, centered about Salduro on the Western Pacific Railroad, has for some time been a source of production of common salt, and during the War potash was produced from its associated brines. In 1920 the Utah Salduro Company, at Salduro, was the largest individual producer of potash in the country. Shortly thereafter potash production

was discontinued at this plant and has not since been resumed. Interest in this area as a source of potash has continued, however, and attempts have been made to raise capital for potash operations here on a large scale. These brines have recently been studied by T. B. Nolan,[13] of the Geological Survey, in coöperation with the Bureau of Mines and General Land Office. The average of 199 samples collected by Mr. Nolan showed that the brine contained 2.89 grams per liter of potassium, equivalent to 3.48 grams per liter of K_2O or about 0.3 per cent of K_2O in the brine. He found that the brine was relatively localized and varied in composition with the character of the bed rock exposed in the tributary drainage area. For example, samples collected from areas adjacent to magnesian limestones were relatively high in magnesia, while those adjacent to granitic rocks were correspondingly high in potash. The brine in the different borings came from several layers, some of which were a mere fraction of an inch thick. The flow from some layers was fairly rapid but from others it barely trickled. His work raises the question whether or not the supply of brine available by surface trenching is sufficient for large-scale operations without resort to deeper seated brines. A deep well at Salduro has shown, within a depth of 200 feet, five horizons that yield brines similar in character to the shallow brines. The deeper brines would probably be even more localized than those near the surface because of the control exercised by buried topography. In view of the fact that by relatively simple treatment these brines may be made to yield not only common salt and potash but also magnesium chloride and metallic magnesium by-products, a study of the nature and abundance of deeper brines in this region would be highly desirable. Here, as in some of the other potash-bearing areas above discussed, the questions of the disposal of by-products and of freight differentials in favor of foreign potash will have an important bearing on the commercial development of the potash.

Wyoming Leucite

Leucite is a potash-bearing silicate mineral contained in certain volcanic rocks. In Sweetwater County, Wyoming, there is a group of buttes, mesas, and tablelands known collectively as the Leucite Hills, which are capped by or composed of a leucite-bearing lava, to most of which the name wyomingite has been applied. These hills lie mostly 20 miles or more northeast of the city of Rock Springs on the Union Pacific Railroad.

According to Schultz and Cross,[14] the available leucite-bearing rocks comprise in round numbers about two billion tons, 10 per cent of which is

[13] T. B. Nolan, "Potash Brines in the Great Salt Lake Desert, Utah," *U. S. Geol. Survey Bull.* **795,** 25–44 (1928). (Separate Chapter, 795-B, published 1927.)

[14] A. R. Schultz and Whitman Cross, "Potash-Bearing Rocks of the Leucite Hills, Sweetwater County, Wyo.," *U. S. Geol. Survey Bull.* **512** (1912).

K_2O and 10 per cent alumina (Al_2O_3). They thus contain approximately two hundred million tons of each of these substances. The potash, if recoverable on any basis fairly competitive with foreign potash, could supply all needs of this country for generations to come. Similarly, the alumina, if available, could be used for the manufacture of aluminum and for other purposes.

The fact that in Italy some potash has been produced commercially from leucitic lava by an acid extraction process has led many to hope that the wyomingite and associated rocks of the Leucite Hills could be utilized as a source of potash. These rocks, however, differ in character and composition from those of Italy and it has not been shown that the processes effective there could be used to advantage here. Many processes for the extraction of potash from silicates have been devised and during the World War an experimental plant utilizing leucite was in operation for a brief period at Green River, Wyoming, but to date no commercial utilization of wyomingite has been practicable.

The fact that the wyomingite localities are not far removed from the great phosphate fields of western Wyoming, southeastern Idaho, northeastern Utah, and southwestern Montana has led many to hope that some plan of utilization might be effected which would involve both potash and phosphate. Indeed, operations of this sort are in contemplation now by at least one private company.

Here, again, it is practically certain as in the case of greensand that by-products would have to be produced and marketed to share with potash the costs of manufacture. Here, too, a freight differential in favor of foreign potash would probably be effective. Thus markets would be restricted and limitations on production would accordingly be imposed.

Utah Alunite[15]

During the World War one of the principal sources of potash production was alunite, a hydrous basic sulfate of potassium and alumina ($K_2O \cdot 3Al_2O_3 \cdot 4SO_3 \cdot 6H_2O$), which, when pure, contains, besides water, 11.4 per cent of K_2O, 37 per cent Al_2O_3, and 38.6 per cent of SO_3. It is insoluble in water and is usually contaminated with silica and other impurities. At many places part of its potash is replaced by soda. It is concentrated in veins or vein zones and is also disseminated through zones in porphyry, where the general shattering and alteration of the country rock indicates that it has been produced or introduced by common vein-forming agencies.

In Italy alunite has been utilized in the manufacture of alum since the thirteenth century. In the United States it has been reported from at

[15] U. S. Geol. Survey Min. Res. of the United States, Pt. II, Potash, 1917, 429–33 (1919). See also Min. Res., Potash, 1916 and 1918 and *U. S. Geol. Survey Bulls.* **511** and 620.

least six states, but the only deposits that give promise of commercial development are those near Marysvale, Utah. The quantity available for potash supplies near Marysvale is not known. At one group of claims Loughlin[16] estimated about 46,000 tons of K_2O for each 100 feet of depth. The depth, however, is not known and from the nature of the deposit seems likely not to be great. Evidence thus far available suggests, therefore, that the quantity of recoverable potash from this source is not so large as at some of the others above considered.

Processes of recovery include roasting, leaching, filtration, and evaporation and the obtainable products include potassium sulfate, alum, alumina, and sulfuric acid. No commercial production has taken place since 1919. Though intermittent experimental work has been done, no process that will produce potash cheaply enough to compete in present markets has been devised. The questions of marketable by-products and of differential freight rates thus enter into any plan for the commercial utilization of alunite.

Technological Investigations

In addition to core testing, Government agencies are also engaged in technological investigations to develop improved processes of extraction of potash from some of the minerals mentioned above. Special impetus was given to these activities by the passage of the act (Public No. 781—70th Cong., approved Feb. 20, 1929) which provided $50,000 a year for four years for joint investigations by the Bureau of Mines and the Bureau of Soils to determine "more improved methods and cheaper processes for recovering potash from the leucite, alunite, and other potash-bearing deposits of the United States."

Progress is being made in these investigations but results have not yet reached the stage of publication.

Outlook

Very high-grade potash is now being made at Searles Lake, California, under conditions which permit increase in production in proportion to the ability of producing companies to market the borax, which appears to be a necessary by-product of potash exploitation there.

In the Permian basin sufficient supplies of potash salts have been demonstrated to be present to assure freedom of the country from foreign monopoly during any future emergency, if production problems are solved. Chief among these are transportation and marketing, though there are also problems of mining and chemical engineering to be met. Private companies are about to undertake this work. More doubtful sources are

[16] G. F. Loughlin, "Alunite Developments near Marysvale and Beaver, Utah," *U. S. Geol. Survey Bull.* **620**, 257–8 (1916).

the greensand, leucite, and alunite deposits and the brines of the Great Salt Lake Desert mentioned above, together with others which it has not been feasible to discuss in this paper.

There can be little doubt that the potash industry in this country is here to stay. Its expansion through the development of additional sources of supply may be confidently expected, both because of the increasing consumption, which is already foreshadowed by the latest figures (1928), and because of the earnest attention now being given here to problems of potash production. Importations of foreign potash will continue because freight differentials in its favor will probably persist at many centers of consumption. The presence in this country of so many sources of potash and the knowledge already gained regarding their possible exploitation will serve as a check on the prices of foreign supplies. The American farmer may therefore feel assured that his potash needs will henceforth be fully and cheaply met.

Potash Storage and Loading at Hamburg, Germany. The potash storage and loading installation, still under construction at Hamburg, Germany's principal potash harbor, has cost in the neighborhood of $1,600,000. Its principal warehouse possesses a capacity of 120,000 metric tons, and the quay is long enough (over 900 ft.) to permit two ocean-going vessels to load at the same time. In the warehouse an elaborate system of conveyors reduces human power to a minimum. Four hundred tons of loose or bagged potash may be discharged from warehouse into vessel within one hour. By means of various technical contrivances different grades of potash may be discharged into a vessel's hold at the same time. Automatic scales, bagging arrangements, and bag-sewing machines are also included. An interesting innovation is the heating of all means of conveyance to prevent caking.—*Chem. Age*

Two New Vitamins Discovered. No less than two new vitamins have recently been discovered by English scientists. Katherine Hope Coward and her colleagues at the Pharmaceutical Society in London, have just published a paper describing a new vitamin which has somehow escaped notice before. Scientists do not yet know whether this new factor is necessary for the human race, but Miss Coward's experiments have proved that it is necessary for the growth of that all-important animal, the experimental rat. No name has yet been given to this vitamin. It has been found in fresh milk, lettuce, grass, ox muscle, liver, and wheat embryo.

The other new vitamin has recently been described by Vera Reader of the Biochemical Department, Oxford University. The original Vitamin B was said to prevent beri-beri. Scientists found later that Vitamin B really consisted of at least two separate factors, and they decided to call them B1 and B2. Miss Reader now has found that in the Vitamin B of yeast there is a third growth factor which is chemically distinct from either of the other two. She suggested the name B3 for this new factor. Like B2, it can be destroyed by heat.

The pellagra-preventing factor in foodstuffs, known as P–P, was also once thought to be part of Vitamin B.—*Science Service*

THE CHEMICAL SECTION OF THE DEUTSCHES MUSEUM*

WILHELM PRANDTL, UNIVERSITY OF MUNICH, MUNICH, GERMANY

In the February, 1929, issue of THIS JOURNAL, Ralph E. Oesper has described "What a Chemist May See in Europe." He sketched for the chemical traveler a general survey of all Europe, citing the localities of interest either because of their current importance or historic significance. Few travelers will be able to visit the numerous countries, cities, laboratories, and investigators he mentioned. If a choice must be made, the traveler would naturally select the place where there is most to see and where a general view may be had of the entire field. Fortunately, there is such a place which offers all of this and more, namely, "*Das Deutsches Museum für Meisterwerke der Naturwissenschaft und Technik*" in Munich. This is usually referred to as the "*Deutsches Museum*" and this paper will deal with its chemical section.

The Museum was founded in 1903 at the instigation of Oskar von Miller (Figure 1) and under his active guidance it has developed into the largest and finest scientific-technological museum in the world. The building in which the collections are exhibited was begun in 1906 and opened in 1925 (Figure 2). The basic idea of the museum is to demonstrate the development of science and industrial arts. It is to be

> a living history of the investigative and inventive spirit of all times and all peoples, showing in various ways the influence of scientific research upon technology, a hall of fame for those whose thoughts and deeds have so largely molded our present civilization, a source of historic understanding for scholars, a mine of fruitful ideas for the technologist, an example and incentive for all the people.

The name "*Deutsches Museum*" does not signify that its purpose is to demonstrate the development of science and technology in Germany alone, but only signifies that the Museum is a creation of the German nation. All peoples and all times are represented in its collections. That most of the exhibits are of German origin is due not so much to the important part played by the German people in the development of science and industry, as it is to the fact that such specimens were most available. If an American visitor should feel that any important American discovery or invention is not properly represented and wishes to remedy this situation, the Museum authorities will appreciate and welcome his coöperation.

This fundamental principle of universality applies, of course, to the Chemical Section which occupies fourteen rooms on the second floor of the west wing. The first rooms are fitted up as laboratories representative of various epochs and contain characteristic apparatus. Samples of preparations discovered in each period are on display. The apparatus, vessels, preparations, etc., are, in many instances, originals. Only when these were not obtainable were facsimiles made following old cuts and prescriptions.

* Translated by Ralph E. Oesper, University of Cincinnati, Cincinnati.

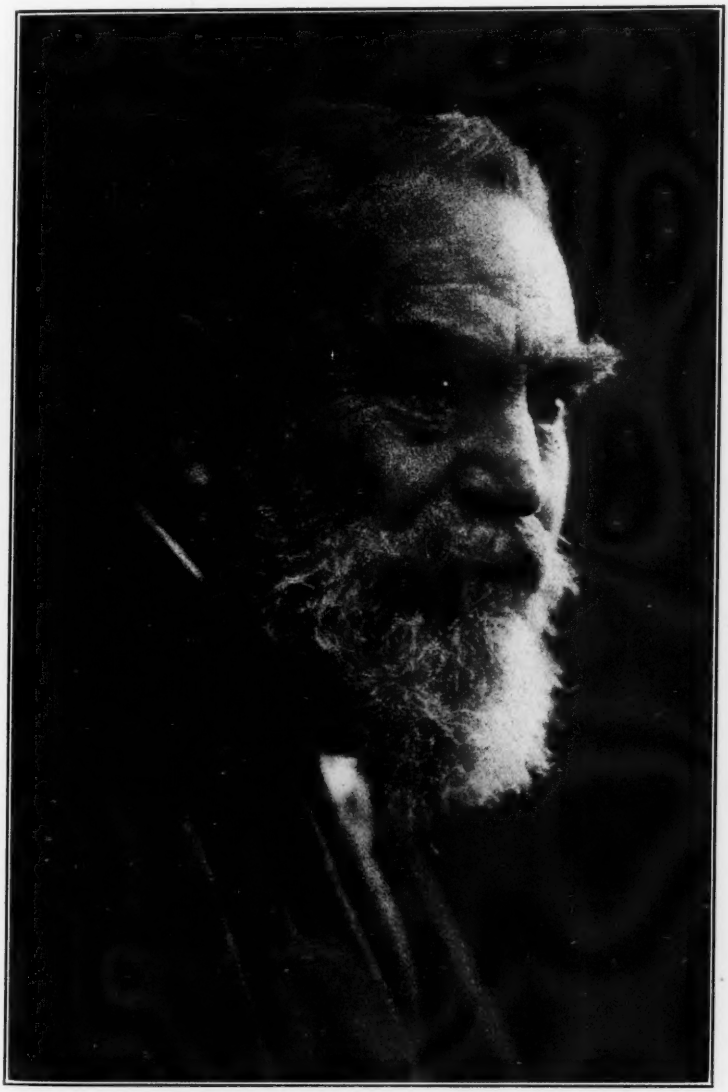


FIGURE 1.—OSKAR VON MILLER, FOUNDER OF THE DEUTSCHES MUSEUM

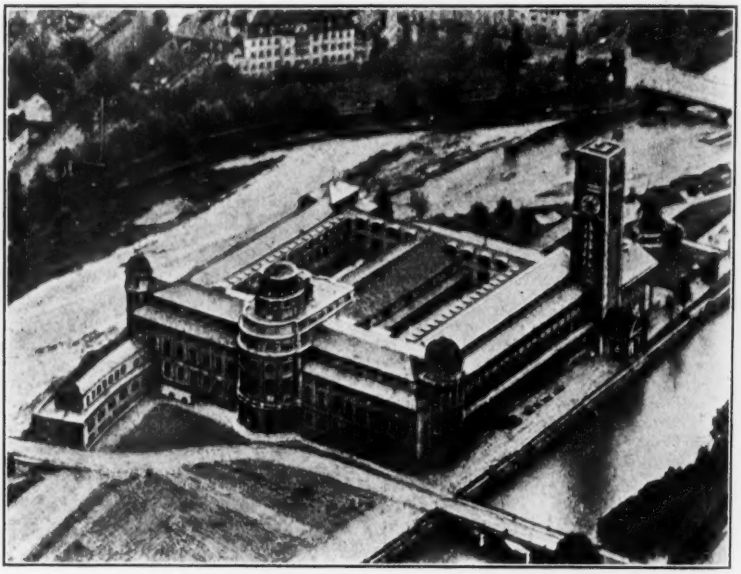


FIGURE 2.—AIRPLANE VIEW OF THE DEUTSCHES MUSEUM IN MUNICH, GERMANY

Pictures of laboratories, apparatus, and famous chemists, appearing in old books are displayed on the walls and give the atmosphere of the period.

The first room (Figure 3) with Gothic vaulting is gloomy and smoke-stained.

> With books around thee piled, and glass
> With many a useless instrument
> With old ancestral lumber blent
> This is thy world.
>
> *Faust, Part I*

This setting reproduces as closely as possible the laboratory of an alchemist of the sixteenth century when the chief aim of chemical endeavor was the transmutation of baser metals into nobler ones, especially into silver and gold. Prominent features are a cupeling hearth with utensils for distilling and subliming, and an assay furnace used in testing the products of the experiments for silver and gold. Retorts and samples of preparations may be seen on the walls. On the study table lies an open book as if the "philosopher" who had been following its directions had just stepped out of the laboratory. From the ceiling hangs a stuffed shark, in the arch of the doorway a crocodile, whose entrails had probably been used in some preparation.

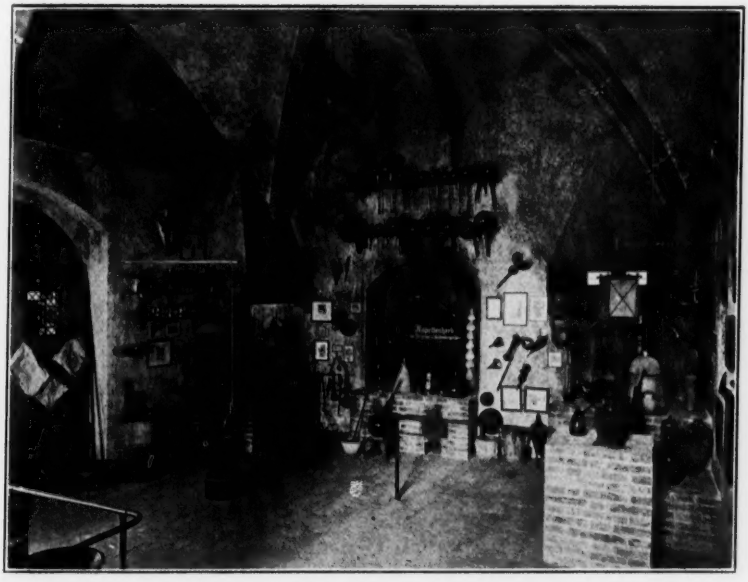


FIGURE 3.—ALCHEMICAL LABORATORY OF THE 16TH CENTURY (ROOM 206)

FIGURE 4.—LABORATORY OF THE MIDDLE AGES (ROOM 207, REAR, AND 208, FRONT)

FIGURE 5.—LABORATORY OF THE MIDDLE AGES (ROOM 208, REAR, AND 209, FRONT)

FIGURE 6.—LABORATORY OF THE 18TH CENTURY (PHLOGISTIC PERIOD)

The inscriptions, pictures, and specimens in the next room (Figure 4 behind arch) recall the beginnings of chemistry in Egypt, the Arabic period and that of the Middle Ages (Albertus Magnus, 1206–1280). A Gothic archway leads to two rooms (208, to front in Figure 4 and to rear in Figure 5; 209, to front in Figure 5) containing furnaces and distillation apparatus such as were described by Hieronimus Brunschwick in his "Distillation Book" (about 1500), Georg Agricola in his well-known work "De Re Metallica" (1556), Lazarus Ercker in his "Mining and Assaying" (1574), and Andreas Libavius in his "Alchymia" (1606). These writers lived in the iatro-chemical period which extended from about the middle of the sixteenth to the middle of the seventeenth century. Following the lead of Theophrastus Bombastus Paracelsus (1493–1541), the chief aim of the chemical workers of this time was the preparation of remedies from natural, mineral, vegetable, and animal products. Other famous workers of this period were such men as John Baptiste van Helmont (1577–1637), Angelus Sala (*circa* 1600–1650), Daniel Sennert (1572–1637), and Johann Rudolph Glauber (1604–1668), who were both physicians and chemists. They are commemorated here by suitable pictures and inscriptions. Preparations discovered then are displayed in antique jars whose labels are written in the old style.

FIGURE 7.—FACSIMILES OF LAVOISIER'S APPARATUS

The study of matter was not pursued for its own sake, but served rather the demands of the crafts and industry, of transmutation and medicine, until Robert Boyle (1627–1691) in the second half of the seventeenth century raised chemistry from this servile position to that of an independent science, to be studied for the sake of the knowledge it brought. The first great problem that scientific chemistry had to solve was the explanation of the processes of combustion and the so-called calcination of metals. As is well known, Johann Joachim Becher (1635–1682) assumed that all combustible materials contained a fire matter which escaped during combustion or when metals were calcined. This principle was termed phlogiston by Georg Ernst Stahl (1660–1734). This erroneous hypothesis, finally overthrown by Lavoisier, prevailed throughout the entire eighteenth century and was upheld by the most prominent chemists. Nevertheless, this century was extremely fruitful in important discoveries. The rear of the room dedicated to this century (Figure 6) contains a large brick fireplace copied from a copper etching in the Encyclopédie of Diderot and d'Alembert. Under the hood is the hearth—the water-bath to the right, the sand-bath to the left, and in the center the stoking device. A wind furnace with its elevated bellows stands in the right corner next to the

FIGURE 8.—LABORATORY OF THE FIRST HALF OF THE 19th CENTURY
(THE LIEBIG PERIOD)

hearth. The room is filled with laboratory utensils. These are faithful reproductions of the apparatus used by Boyle, Boerhaave, Hales, Marggraf, Scheele, Cavendish, Priestley, Mayow, etc. To the right is an exact copy of Priestley's fireplace ("Experiments and Observations on Different Kinds of Air," 1774); above it is a portrait of Stahl. Numerous facsimiles of Lavoisier's apparatus as well as a bust (Figure 7) attest the importance of this investigator. Diagrams, pictures, a collection of the newly discovered materials, all recall the chemical advances of the eighteenth century.

The next room (Figure 8) is devoted to the men who molded chemical thought in the first half of the nineteenth century: J. J. Berzelius (1779–1848), Justus Liebig (1803–1873), Friedrich Wöhler (1800–1882), and Robert Bunsen (1811–1899). Opposite the door stands a digestion hearth. Like much of the other apparatus here, it is an exact copy of the original in Liebig's laboratory at Giessen where he taught until he went to Munich in 1852. Equipment from his Munich laboratory is also in evidence, old forms of his condensers and apparatus for ultimate organic analysis. The apparatus of Berzelius for blowpipe analysis, a collection of Bunsen and other gas burners, an original laboratory table equipped for gas analysis by Bunsen's methods are also preserved here. Charts and pictures recall the electro-chemical theory of Davy and Berzelius, the dis-

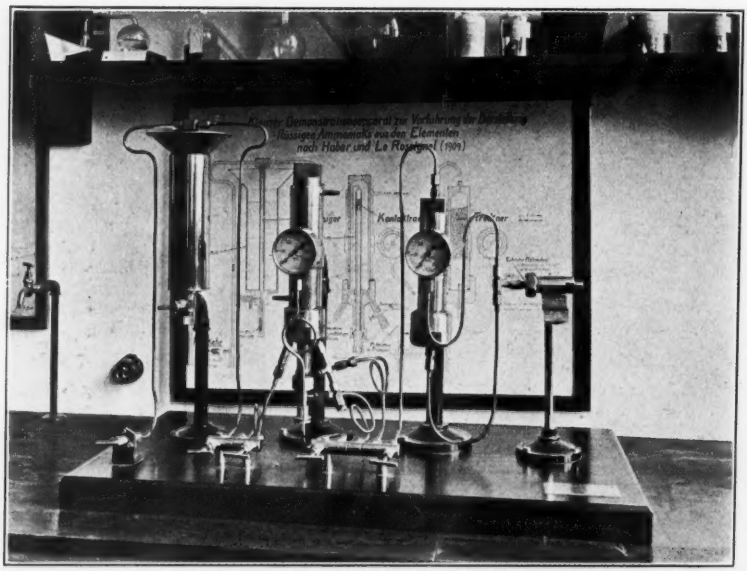


FIGURE 9.—APPARATUS FOR THE SYNTHESIS OF AMMONIA FROM ITS ELEMENTS BY HABER AND LE ROSSIGNOL (1909)

covery of Faraday's laws, Mitscherlich's laws of isomorphism, Dulong and Petit's law, the substitution theory, the discovery of isomerism, the first syntheses of organic materials such as prussic acid by Scheele (1783), oxalic acid (1824), and urea (1828) by Wöhler. There are also several specimens of Döbereiner's lighter, Davy's safety lamps, Natterer's apparatus for preparing liquid carbon dioxide, air pumps, and many other interesting pieces of apparatus on display. The collection of preparations is also continued here and contains specimens of the most important organic and inorganic materials discovered between 1800 and 1850.

The next room illustrates the development of laboratory technic up to the present time. Because of the extensive specialization so characteristic of the present, this development cannot be shown in a single, unified laboratory. The principles of qualitative and quantitative chemical analysis are explained to the layman by charts. The apparatus used in gravimetric-, volumetric-, gasometric-, and electro-analysis, as well as that employed in ultimate organic and micro-analysis is on display. There are also electric furnaces, quartz vessels, apparatus for distillation under low pressures and for the determination of pH. The original apparatus used by eminent investigators is exhibited. Typical specimens are the bomb used by Haber and Le Rossignol (1909) in the synthesis of ammonia from

FIGURE 10.—THE STRUCTURE OF MATTER ROOM
The case in the center contains specimens of all the known chemical elements.

the elements (Figure 9); a train for the washing of precipitates out of contact with the air, used by Emil Fischer, etc. The synthesis of important organic compounds is outlined on charts. It is possible for the visitor, by means of clever devices, to make simple chemical or spectroscopic experiments.

The next room (Figure 10) gives a general survey of the development of the views concerning the structure of matter. A case containing specimens of all the known chemical elements stands in the center. The foundations and development of the atomic and molecular theories are depicted by pithy, significant inscriptions while the work of those responsible for the advance in these fields, J. B. Richter, Proust, Dalton, Gay-Lussac, Avogadro, Cannizzaro, Berzelius, Stas, and Marignac, is commemorated by quotations and pictures. The structure of molecules, the linking and position of the atoms in the molecule as developed by Pasteur, van't Hoff, Kekulé, von Baeyer, and Emil Fischer are shown by models. Gigantic models of simple molecules, such as ethyl alcohol, methyl ether, and benzene, hang from the ceiling, while smaller representations of the more complicated organic compounds are exhibited in the cases. Apparatus used in the determinations of atomic and molecular weights (E. Beckmann. O. Hönigschmid, and others) is also set up here.

The study of the structure of atoms began with the discovery of the relations of chemical behavior and atomic weights and with the formulation of the periodic system by Lothar Meyer and Mendeléeff. It was advanced by electro-chemical observations (Faraday, Arrhenius) and especially by the discovery of Röntgen rays, of radioactivity, as well as by the study of optical and X-ray spectra (Moseley). The course of this development is shown in this room (models of atoms, isotopic varieties of lead, etc.). Chemistry and physics are almost inseparable in this connection and so some of the pertinent material is exhibited in the Physics Section of the Museum.

The great theoretical advances resulting from the scientific study of matter since the end of the eighteenth century have largely been responsible for the creation of chemical industry which from modest beginnings has, in the course of a century, developed into one of the most important branches of manufacturing. This has been particularly true in Germany. The development and importance of chemical industry is shown in the succeeding rooms. The first of these (Figure 11) is devoted to the inorganic chemical industries, the manufacture of acids, alkalies, compounds of nitrogen, chlorine, sulfur, etc. Models of a niter plantation, of a potash refinery, of a plant for the manufacture of fuming sulfuric acid from iron vitriol, of an old English lead chamber, recall the beginnings of the inorganic industries in the eighteenth century. A modern lead chamber plant is illustrated by a model of the installations at Leverkusen of the Farbenfabrik

FIGURE 11.—INORGANIC INDUSTRY

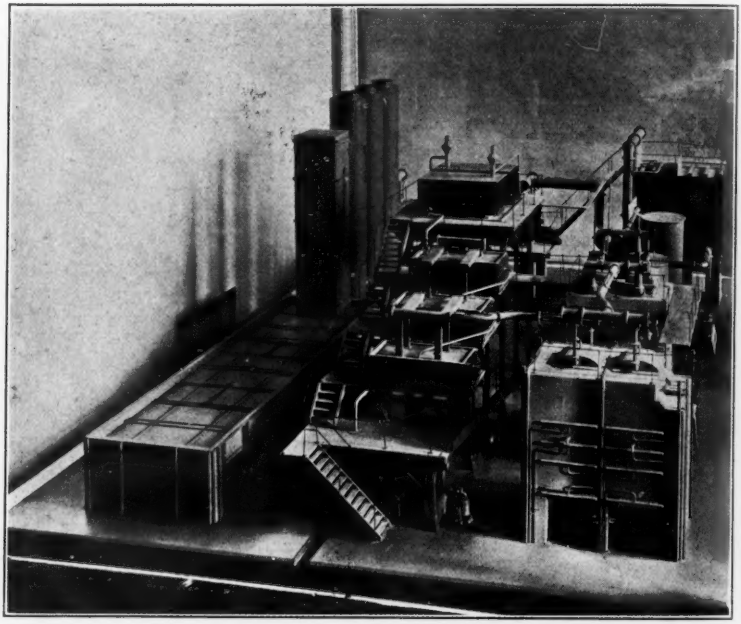
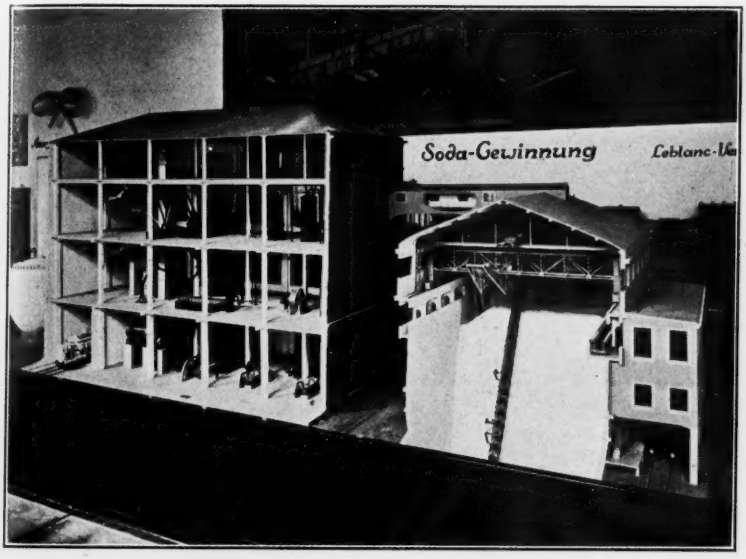
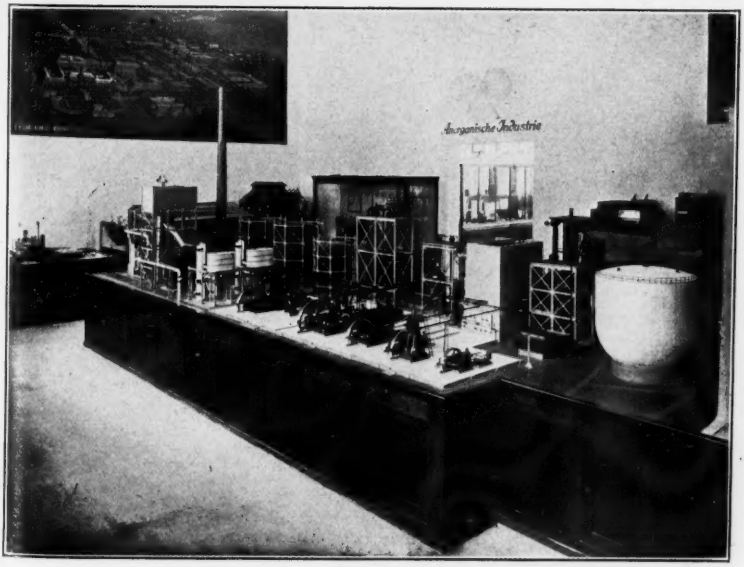


FIGURE 12.—MODEL OF A CONTACT SULFURIC ACID PLANT

vorm. F. Bayer & Co.; the first plant for the manufacture of sulfuric acid by the contact process is shown by a model of the installation of the Badische Anilin und Sodafabrik at Ludwigshafen (Figure 12). The manufacture of Leblanc soda and the concurrent preparation of hydrochloric acid and chlorine are also shown, likewise typical layouts for the manufacture of ammonia soda and sodium hydroxide. The latest triumph in the inorganic field—the preparation of ammonia and of nitric acid from the atmosphere by the process of Haber and Bosch—is shown by a large working model in the center of the room (Figures 13 and 14). The other processes involving the utilization of atmospheric nitrogen are also illustrated—the preparation of nitric acid by an original of a Pauling arc furnace, a model of the Frank-Caro process showing the manufacture of calcium carbide and calcium cyanamide. Electric furnaces used in the preparation of carbide, aluminum, sodium, etc., are on display. Views of the great plants of the I. G. Farbenindustrie at Leverkusen and Merseburg adorn the walls.

In the organic section also there is space for only a limited number of the available exhibits. The most striking is the great tree-like arrangement of the products derived from coal (Figure 15). By following the limbs and





FIGURES 13 AND 14.—PARTIAL VIEWS OF THE PLANT FOR THE PREPARATION OF AMMONIA BY THE HABER-BOSCH PROCESS

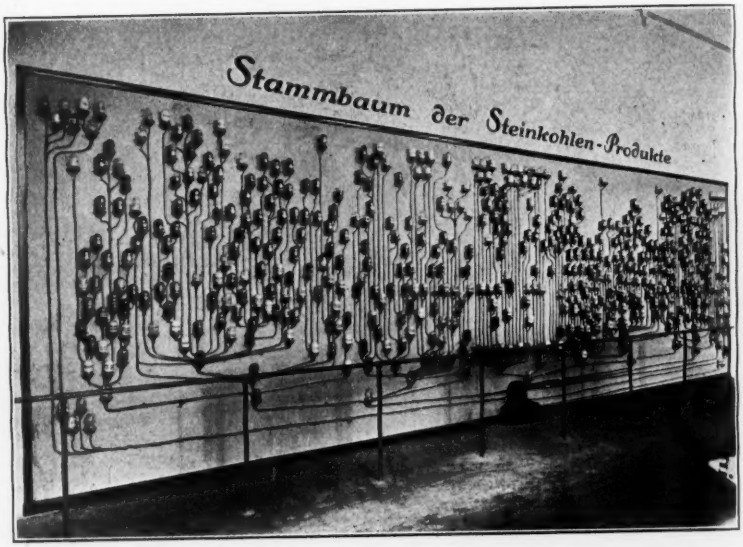


FIGURE 15.—THE PRODUCTS DERIVED FROM COAL

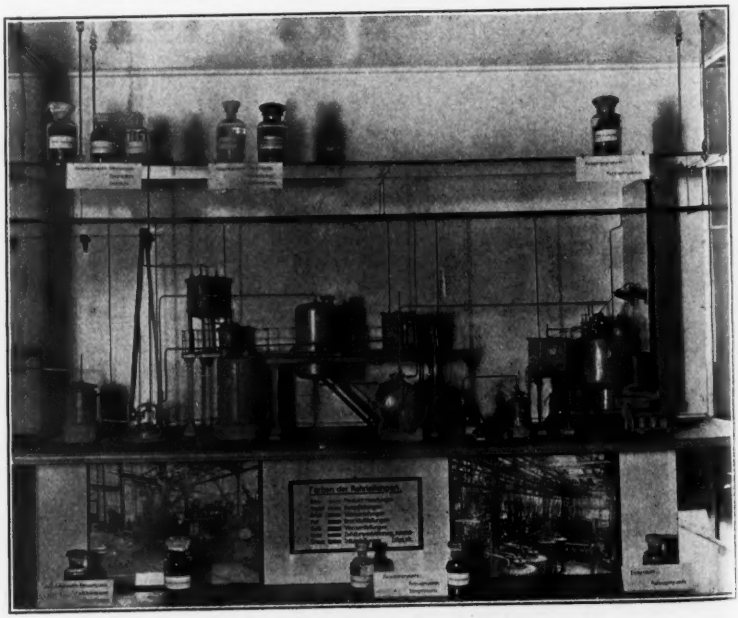


FIGURE 16.—MODEL OF A NAPHTHYLAMINE PLANT

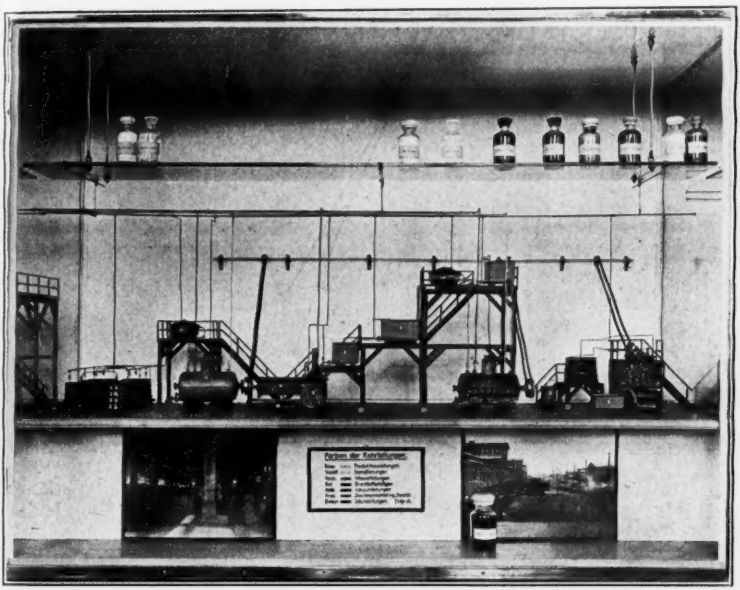


FIGURE 17.—MODEL OF PLANT FOR THE PREPARATION OF FUCHSINE

branches, it is possible to trace the order in which the products, most valuable technically, especially dyes and medicinals and their derivatives, are produced. 550 of the thousands of these materials have been included in this schematic arrangement. Those most important from the historic standpoint have been placed in gilded containers. In the middle of the room is a case showing models of various portions of a dye factory. These include the preparation of naphthalene, nitro-naphthalene, naphthylamine, naphthionates, benzo purpurine, and fuchsine (Figures 16 and 17). The manufacture of indigo is presented in two models, one showing the preparation from the indigo plant, the other the first installation for the manufacture of synthetic indigo (Figure 18). Similarly, the production of natural and artificial coloring matter of the madder (alizarine) is shown as well as the preparation of an indanthrene dye. The working up of lignite and petroleum are shown by tree models and in between are samples of the organic products of the electrochemical industry, especially the derivatives of calcium carbide, including artificial rubber.

A special portion of the organic section is devoted to ethereal oils and perfumes and their history. The plants and animals used as sources of scents, the methods of obtaining the odoriferous compounds from them, and the synthesis of artificial perfumes are all shown. The visitor may test

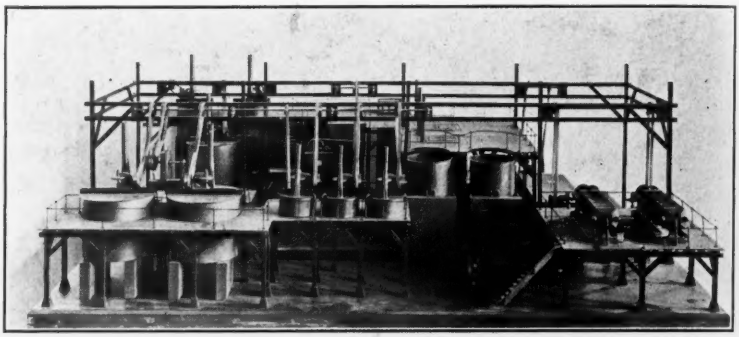


FIGURE 18.—MODEL OF THE FIRST PLANT FOR THE PREPARATION OF SYNTHETIC INDIGO

the odor of artificially perfumed flowers. An Oriental perfume bazaar and a frescoed alcove containing an ancient divan and ointment jars recall the universal significance of perfumes throughout the ages.

The memory of those who founded and developed German chemical industry is glorified in a "Room of Fame" situated between the inorganic and the organic sections. Among those so honored are Robert Hasenclever (Soda Industry); Adolf Frank (Potassium Salts); Rudolf Knietsch (Contact Sulfuric Acid); Ignatz Stroof (Electrolysis of Alkali Salts); Heinrich Caro, Heinrich von Brunck, Alexander von Martius (Dyes). Their portrait-reliefs are included in the frieze. Important commercial chemical products and historical data relative to their manufacture are displayed in cases. Original records and documents pertaining to chemical industry occupy a table in the center of the room.

The last two rooms of the Chemical Section of the Museum are devoted to the chemistry of foods and medicine. The most widely used foods have been arranged as typical meals. Their content of fat, protein, and carbohydrate is shown, together with their food value in calories and their cost, so that the visitor can calculate and determine, for himself, what combination of foods best fits his needs and his means. Wall charts and anatomical preparations show the digestive organs. The special apparatus used in the investigation of problems of nutrition is on display. The possibility of preparing synthetic nutrients and the methods of preserving foods are shown.

An entirely different atmosphere prevails in the last room. An apothecary shop of the 18th century has been set up here (Figure 19). It might fittingly be called the Unicorn Apothecary because of the symbol over the door and on the ceiling. Its shelves and cases display long rows of beautiful old porcelain and glass vessels whose contents make up a rare collec-

FIGURE 19.—HISTORICAL APOTHECARY SHOP

tion of remedies, some of them quite remarkable. *Animalia*, such as dried toads, mummy powder, boar's teeth, human and snake fat, also *Preciosa*, such as hyacinth, sapphire, emerald, and topaz—to all these our ancestors ascribed medicinal virtues. In direct contrast to this strange assemblage, the shop also contains specimens of more modern and also the newest remedies.

This completes the description of the Chemical Section of the Deutsches Museum, but important divisions of chemical technology have a place in other sections of the museum. For example, in Mining and Metallurgy are found exhibits illustrating the production of coal, rock salt, potash salts, ores, and metals. There are special sections for Glass and Ceramics, Paper, Textiles, Photography, Agriculture, Brewing, and Distilling. These industries which also deal with the production of chemical materials and the enhancement of their value are, for the most part, much older than the purely chemical industries and consequently have long had independent existences. Because of the close relationship between physics and chemistry, particularly in recent times, the chemist will find in the Physics Section much that he may have sought in the Chemical Division.

The building program of the Deutsches Museum has not been completed as yet. A wing to house a great scientific-technical library and another

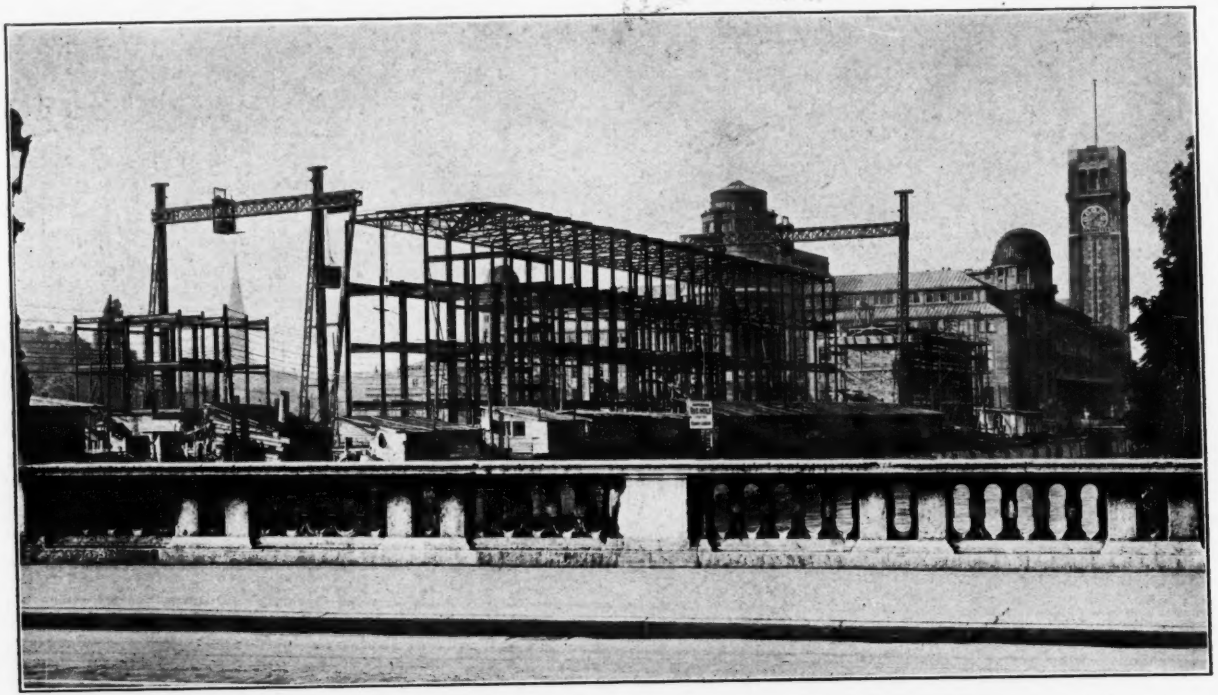


FIGURE 20.—STEEL FRAMEWORK OF THE LIBRARY BUILDING (SEPTEMBER, 1929)

wing with assembly and lecture rooms are to be added to the present buildings (Figure 2). These new portions are now under construction. Figure 20 shows the steel framework of the library wing, as it appeared in September, 1929. But even when these two buildings are finished and furnished, the Museum will not be complete; nor will it ever be finished so long as science and technology continue to develop.

FIGURE 20. STEEL FRAMEWORK OF THE LIBRARY BUILDING (SEPTEMBER, 1929)

CHIEF OF FOOD CONTROL TO BE APPOINTED IN DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

The United States Civil-Service Commission states that eligibles are desired for the position of chief of food control, Food, Drug, and Insecticide Administration, Department of Agriculture, Washington, D. C., and to insure the appointment of a thoroughly qualified man for the work the method of competition will be as follows:

The qualifications of candidates will be passed upon by a special board of examiners, composed of D. B. DUNBAR, Assistant Chief of the Food, Drug and Insecticide Administration, Department of Agriculture; HARRISON HOWE, Editor of the *Journal of Industrial and Engineering Chemistry;* and F. W. BROWN, Assistant Chief of the Examining Division of the U. S. Civil-Service Commission, who will act as chairman of the committee. For the purposes of this examination all of these men will be examiners of the Civil-Service Commission.

The duties are to supervise and direct the scientific and technical work necessary in enforcing the terms of the Federal food and drugs act as they apply to foods, and similar work necessary in the enforcement of the tea inspection and import milk acts. This involves not only the immediate supervision of the staff of the Food Control unit, consisting of approximately 35 people, including chemists, bacteriologists, and food specialists, but also the general direction of and responsibility for the scientific and technical operations of the field force in applying the law to interstate shipments of food products. He will supervise the work involved in the development of analytical methods for the detection of new forms of adulteration and the improvement of existing methods. He will determine the particular food projects to be engaged in during any specific period and will pass upon the adequacy of the analytical evidence in food cases brought under the food and drugs act and in cases under the import milk act. There will be a great many direct contacts with representatives of the food industries requiring tact, firmness, and good judgment, so that it is essential that a man of strong personality be secured. He will be required to keep in touch with the latest developments in the food industries and in food chemistry.

The entrance salary is $5600 a year. Higher salaried positions are filled through promotion.

Applications will be accepted by the Civil-Service Commission until March 26th. Full information may be obtained by communicating with the United States Civil-Service Commission, Washington, D. C.

How Hard Is Diamond? On the scale of hardness talc is rated 1, rocksalt 2, calcite 3, fluorite 4, apatite 5, feldspar 6, quartz 7, topaz 8, corundum 9, and diamond 10, but this does not give a quantitative value of the relative hardness. In reality corundum is eight times as hard as topaz and diamond is 140 times as hard as corundum.—*Sch. Sci. Math.*

MODERN CONCEPTIONS OF ACIDS AND BASES

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The Traditional Definitions of "Acid" and "Base"

As is the case in all actively growing sciences, the fundamental concepts of chemistry are not fixed, but change with the generations. Since these changes do not take place simultaneously in the minds of the whole chemical world-group, diversity of usage is to some extent a chronic and unavoidable condition. Nevertheless, most chemists agree that such diversities should be reduced as much as possible by periodic stock-takings and by the wide advertisement and critical examination of proposals for change.

Examples of concepts now undergoing rapid evolution are not difficult to find. It has, for instance, become necessary of recent years to strip the term *element* of certain traditional meanings, in order to retain for it others of greater importance. The idea of *atoms* means something far less simple to us than to our fathers. *Oxidation*, *reduction*, and *valence* are currently used in widely different senses by different men, while a recent hasty survey[1] disclosed rather marked discrepancies in the definitions of *acid* and *base* given in standard elementary texts and in certain specialized monographs.

In order to understand the newest proposals in the terminology of acids and bases, it is necessary briefly to review the history of these concepts for the last half century or so. The distinctive sour taste of acids gave its name to this group of substances very early in the development of science, but the bitter-soapy taste of strong bases was apparently not recognized as distinctive of their class. Instead, it was the *residual*, *fundamental*, and hence *basic* character of the materials left behind when the acid principles of salts were volatilized that struck the attention of early investigators, and so the names *base* and *basic* became complementary to *acid* and *acidic*.

When it was noticed that very sour solutions attacked metals and carbonates with effervescence, and also produced certain effects on indicators, these phenomena became the characteristic evidence of acidity. A confusion now arose between the substances whose water solutions are acid and the solutions themselves, so that even today some call the pure hydrogen compounds *acids*, while others restrict the term to their solutions and many apply it to both. This confusion was only intensified when it was found that the completely dry liquid or gaseous hydrides of non-metallic radicals failed to exhibit the ordinary acid properties, so that sodium could be distilled unattacked in dry hydrogen chloride. As the behavior of bases became better understood, it was seen that most of the materials which undid or neutralized the effects of acids were substances which either contained the hydroxyl radical, or could be considered to form it on contact

[1] N. F. Hall, "New Views on Acids and Bases," *The Nucleus*, Boston, Jan., 1929, pp. 87–91.

with water. This atom-group then became uniquely associated with basic properties in the minds of most chemists, and the fact that acid behavior could be neutralized in just the same way in the total absence of hydroxyl groups (as for example in liquid ammonia) was largely lost from sight.

The Arrhenius theory of incomplete ionic dissociation brought with it a number of new ideas. Recognizing the so-called hydrogen and hydroxyl ions as the true carriers of acid and basic properties in aqueous solution, and largely distracting attention from other solvents by its success when applied to water, this theory contributed greatly to our knowledge of acid-base equilibria, and imposed its peculiar definitions in the place of the older and more empirical concepts. According to one group of the followers of Arrhenius, an acid is a substance containing hydrogen, which forms hydrogen ions when dissolved in water, and a base is a hydroxyl compound which forms hydroxyl ions on solution. According to this view NH_3 is not a base, but its hydrate is. This formulation has long been opposed by such investigators as Hantzsch, Kahlenberg, and Armstrong, on a variety of grounds, but their objections have usually been coupled with special views of their own, and have generally been ignored by the great majority of followers of Arrhenius and Ostwald.

Modern Objections to the Traditional Definitions

Even as long ago as 1896, Heinrich Goldschmidt, though a convert to the views of Arrhenius, recognized that the characteristic properties of bases were just as marked in solvents such as aniline, where no hydroxyl ions could be present, as in water. Within recent years the earlier dissenters have been joined by others. Many wider definitions of acids and bases have been tentatively proposed by G. N. Lewis, Cady, Germann, and others[2] and the chorus of protest against the Arrhenius formulation has grown in volume. Some of the objections to this formulation may be stated as follows:

(1) The principal substance present in acid aqueous solutions, and the one which gives them the properties which we summarize as "acidity" is not the free hydrogen ion or proton. In fact modern evidence indicates that there is *no* solvent in which any appreciable concentration of free protons is likely to exist, any more than of free electrons.

On the contrary, because of its infinitesimal size in relation to its charge, the proton will always be found attached for the most part to some other atom or group of atoms in any system except a gas under peculiar conditions of excitation. (Of course if it is attached to an *electron* the resulting group may have a transitory existence as atomic hydrogen.)

Thus in water solutions the proton almost always exists in a *solvated* form such as $H^+(H_2O)$ or $H^+(NH_3)$ or else combined with an anion as in

[2] See Walden, "Salts, Acids, and Bases," McGraw-Hill, New York, 1929.

$HC_2H_3O_2$, H_2O, or HSO_4^-. In liquid ammonia, the proton is always in the form of ammonium ion, ammonia, or $H\overline{X}$, and in an acid solvent like glacial acetic acid there is evidence that only the corresponding forms are present as $H^+(HC_2H_3O_2)$, H_3O^+, NH_4^+, HAC, HX in general, etc.[3]

Of course in a solvent such as acetic acid or benzene the ions will be more or less completely *associated* (due to the low dielectric constant) and the conductivity may be so low as to indicate that practically no *free* ions are present. Thus it is not really the proton but the *hydronium* ion $H_3{}^+O$ which is the carrier of the characteristic properties of acid solutions in water, and to every other solvent corresponds another characteristically *acid* cation. On the other hand, as Franklin[4] has brilliantly demonstrated, there are as many different analogs of the hydroxyl ion as there are solvents of the type HX. To mention only two, in ammonia it is $N\overline{H}_2$, in acetic acid it is the acetate ion that makes a solution *basic* (*e. g.*, KNH_2 is a strong base in the ammonia system and $KC_2H_3O_2$ in the acetic acid system, just as is KOH in water). Thus while the "hydrogen" (hydronium) and hydroxyl ions are as a rule peculiar to the solvent water, acidic and basic properties may appear in any solvent.

Let us now examine somewhat more closely the process of *neutralization* as ordinarily carried out. Suppose that we first pass dry hydrogen chloride into water so as to form a one-tenth normal solution. There is a vigorous reaction which runs practically to completion according to the equation

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^- \qquad (1)$$

The resulting solution contains almost no molecular HCl at all, but only chloride and hydronium ions (which of course may also be further hydrated). We now dissolve solid potassium hydroxide, consisting of a crystalline lattice (more or less jumbled) of K^+ and $O\overline{H}$, in a further quantity of water. The ions remain separated, surrounding themselves (especially the cation) with a sheath of water, and we are now ready for the titration. A hydrogen electrode, which measures the escaping tendency or *activity* of protons, shows a relatively positive[5] potential in the highly acid solution, because the protons are relatively loosely held by the water molecules. As the neutralization proceeds, however, the concentration of hydronium ions diminishes,

$$H_3O^+ + O\overline{H}^- \longrightarrow 2H_2O \qquad (2)$$

and the proton activity diminishes in proportion, since the protons can hardly escape at all once they have been taken away from the water mole-

[3] Hall and Conant, *J. Am. Chem. Soc.*, **49**, 3047 (1927).

[4] Franklin, *Ibid.*, **46**, 2137–51 (1924).

[5] In regard to the sign of the potential of the hydrogen electrode, the convention of the "International Critical Tables" is used. See Clark, "Hydrogen-Ions," pp. 258–60. This is opposite to that used by Lewis and Randall.

cules by the hydroxyl ions. At all times the concentration of hydronium ions is related to the concentration of hydroxyl ions by the expression

$$\frac{(H_3O^+)}{(H_2O)} \cong \frac{10^{-15.7}}{(\overline{OH})} \qquad (3)^6$$

Note that the hydrogen electrode, on which we rely for a quantitative measure of true *acidity* (hydrogen-ion activity), tells us *nothing directly about hydroxyl ions*. The hydroxyl ions are *basic* merely because they seize upon and imprison the protons which enjoyed relative liberty as guests of the water molecules while they were parts of hydronium ions. Evidently the hydroxyl ions owe their potency to the fact that water is such a weak acid, but if this is the case, the negative ions of other weak acids should have the same effect as hydroxyl ions, differing from them only in degree. That this is so may be seen by titrating the hydrochloric acid not with potassium hydroxide, but with potassium *acetate* solution. The acetate ions also rob the hydronium ions of their protons, but less violently, because

$$\frac{(H_3O^+)}{(HAc)} \cong \frac{10^{-5}}{(\bar{Ac})} \qquad (4)$$

However, we need not use anions to reduce the activity of protons in the solution: we can "neutralize" the acid just as readily with the aid of neutral molecules of ammonia,

$$(H_3O^+) + NH_3 \longrightarrow NH_4^+ + H_2O \qquad (4a)$$

and, in fact, we find that ammonia is more effective than acetate ion, but less so than hydroxyl ion.

$$(H_3O^+) \cong 10^{-9} \frac{(NH_4^+)}{(NH_3)} \qquad (5)$$

The fact that ammonia, if present in larger amount than necessary to neutralize the acid, will then begin to remove protons from water itself

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + \overline{OH} \qquad (6)$$

is largely irrelevant to the discussion. The essential feature of all three processes is the same, and we can write

$$H_3O^+ + B \rightleftharpoons H_2O + BH^+ \qquad (7)$$

where B may be either $\overline{OH}$, $\bar{Ac}$, or NH_3.

In another sense, the water combined with the proton is itself irrelevant, since we might have been titrating a weak acid like phenol or acetic acid where the protons were originally combined with anions, or we might

[6] Equation 3 means that in a solution one normal in hydroxyl ions, only one proton will exist in the form of hydronium ion for every five quadrillion that are in the form of water molecules. Even in a neutral solution there will be five hundred million water molecules for every hydronium ion, while in a one normal acid the ratio is nearer fifty to one.

(with potassium hydroxide) have titrated the acid *ammonium ion* instead of the acid *hydronium ion*.

$$NH_4^+, (Cl^-) + (K^+), O\overline{H} \longrightarrow NH_3 + H_2O + (K^+, Cl^-) \qquad (8)$$

If we pare the process down to its bare essentials, we have as the general equation for a neutralization:

$$H^+ + B \rightleftharpoons A \qquad (9)$$

where H^+ is the proton, whatever it may be combined with, and the charges of B and A may take any values, provided only that the charge of A is one unit more positive than that of B.

Incidentally, this discussion should have made it clear that the formation of *water* is neither a necessary nor a sufficient criterion for a neutralization reaction. In benzene solution, we may titrate the acid HCl with NH_3, and neutralize it, without forming water. In anhydrous acetic acid solutions, the writer has many times titrated dry HCl with dry $NaC_2H_3O_2$ and obtained e. m. f. values with various electrodes which were entirely comparable, *mutatis mutandis*, with those obtained in titrating HCl with NaOH in water.

If we define a salt as a grouping of oppositely charged ions which do not neutralize each others' charge, it should be clear, as Brönsted[4] has pointed out, that *salt formation* is not characteristic of neutralization, for in the reaction

$$H_3O^+, \overline{Cl} + Na^+, O\overline{H} \longrightarrow Na^+, \overline{Cl} + 2H_2O \qquad (10)$$

the ions of the salt ($Na^+, \overline{Cl}$) were already present before the reaction, and the other ionized substance ($H_3O^+, O\overline{H}$) *disappears* during the change. We start with two salts and end with one.

Returning once more to the general equation

$$A \rightleftharpoons H^+ + B \qquad (9a)$$

(to write it the other way around), we see that (*a*) it may serve equally well to formulate the dissociation of such acids as

$$HAc \rightleftharpoons H^+ + \overline{Ac}$$
$$NH_4^+ \rightleftharpoons H^+ + NH_3$$
$$H_2O \rightleftharpoons H^+ + O\overline{H}$$
$$H_3O^+ \rightleftharpoons H^+ + H_2O$$
$$HSO_4^- \rightleftharpoons H^+ + SO_4^{=}$$

whatever the *charge-type* of the acid may be, and (*b*) all the different ions and molecules designated by B have one thing in common, namely a considerable affinity for protons. But we have seen that this affinity for protons is what we regard in the case of the hydroxyl ion as the characteristically *basic* property. In other words, if hydroxyl ions make a solution basic, so in varying degrees do all the other substances enumerated. So indeed,

to a vanishingly small extent, do the anions even of such strong acids as HCl and $HClO_4$, and so do even such relatively inert molecules as those of acetic acid, since when $HClO_4$ is dissolved in this solvent, appreciable concentrations of the ions $H^+(HC_2H_3O_2)$ and ClO_4^- appear to be present.

The Present Proposal

Such considerations as these have led Brönsted[7] and Lowry[8] to the following simple and radical definition.

> If the reaction $A \rightleftharpoons B + H^+$ can occur at all, A may be called an acid, whatever its charge, and B may be called a base, irrespective of the actual stoichiometrical course of the reaction.

The actual reaction, by the way, will *always* differ from the formulation given because of the impossibility of the protons existing uncombined.

This definition, or convention, is capable, as Brönsted has clearly shown, of bringing simplicity and order into a vast field of complicated phenomena and with its aid, he has stated clearly the formal relationships which determine the strength of an acid under all conditions and the influence of the solvent on the dissociation constants of acids. At the same time the use of the word *base* to designate anything which may to any extent combine with protons practically makes all substances bases, and in particular would force us to call bases even the strongest acids! Potassium hydroxide in this view is not a base, but merely a salt like KAc, while the anions $\bar{O}H$ and $\bar{A}c$ are the bases concerned. The terms *protophilia* and *hydrophilia* have been proposed to describe the tendency of a molecule to unite with protons, and it would seem that some such word as *protophile*, forbidding as it is, would arouse less prejudice than the term *base* used in such a broad and subversive manner. It seems desirable, however, to follow Brönsted in calling substances that give up protons "acids" whatever their charge. We should of course be careful to note that a substance not an acid may react with a solvent to form one, and that a dissolved acid may not exist as such in the solution. (*Cf.* $SO_3 + 3H_2O \rightleftharpoons 2H_3O^+ + SO_4^=$, and $HCl + H_2O \rightleftharpoons H_3O^+ + \bar{Cl}$.)

We should especially avoid saying that "dry HCl is not an acid, but its aqueous solution is." Dry HCl *is* an acid as above defined, and there is little doubt that when liquid HCl is studied from this point of view it will be found to have a relatively high hydrogen-ion activity as have liquid $HClO_4$, H_2SO_4, $HC_2H_3O_2$, etc. Its aqueous solution on the other hand is not "an acid," but a mixture of the acid, H_3O^+, the weak base or protophile, $\bar{Cl}$, and the somewhat stronger base, H_2O.

[7] Brönsted, *Chem. Reviews*, **5**, 284–312 (1928); *Berichte*, **61**, 2049–63 (1928); *J. Phys. Chem.*, **30**, 777–90 (1926); *Rec. Trav. Chim. Pays-Bas*, **42**, 43, 1048 (1923).

[8] Lowry, *Chem. & Ind.*, **42**, 43 (1923); *Trans. Faraday Soc.*, **20**, No. 18 (1924).

Such questions of nomenclature and definition as these would be of relatively little moment if water were the only solvent accessible to our investigation, or if acid-base equilibria in non-aqueous solvents were as relatively unimportant as one would suppose from a survey of the present literature of physical chemistry.

In the last few years, however, there has for the first time been developed a theory of ionized solutions (Debye-Hückel Theory) sufficiently powerful to give real promise of bringing order into this field, and at the same time new experimental methods bid fair to furnish quantities of data by which the theory may be thoroughly tested. On the practical side, one may mention the fact that numerous industrial processes, carried out in non-aqueous solvents with the aid of acid or basic catalysis, await scientific study with a view to improving their yields, while the whole physiology of lipoid phases has remained largely a closed book for lack of just such knowledge as may reasonably be expected from the development of generalized acidity theory.

From a more fundamental point of view, acidity phenomena constitute *proton-chemistry* in the same sense that oxidation-reduction reactions comprise the chemistry of the *electron*. These are the two fundamental building stones of the universe, and no apology is necessary for emphasizing their importance in the condensed systems with which the chemist ordinarily operates.

The Nature of Acids

When we come to a consideration of the actual substances which are acids, we find that they may conveniently be classified by two properties: strength and charge type. We cannot measure and compare the actual intrinsic strengths of two acids because the activities of their ions and undissociated molecules can be measured only in terms of some arbitrary convention. We shall, however, adopt the usual convention that the dissociation constant in infinitely dilute aqueous solution

$$K_a = \frac{(H_3O^+) \times (X^-)}{(HX)}$$

is the proper measure of acid strength, and we may then arrange all known acids in a diagram such as Figure 1, in which the different charge types are separated horizontally into columns, and the vertical height of any formula indicates the strength of the corresponding acid on a logarithmic scale. Only the values between 10^0 and 10^{-14} can be regarded as reliable. The others depend on various rather uncertain assumptions, and extrapolations. Some of these extreme values will form the subject of later discussions.

From a study of this table we may learn, if we like, what it is that makes a molecule acid. First of all, the electrical condition of the molecule is

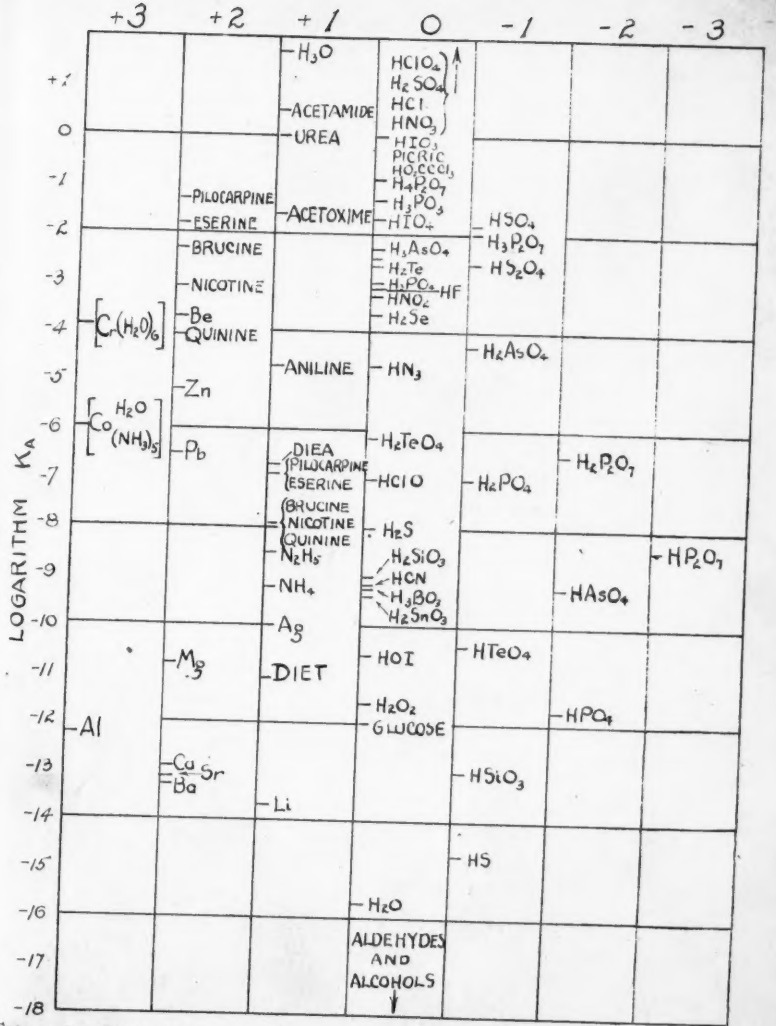


FIGURE 1.—CLASSIFICATION OF CERTAIN COMMON ACIDS BY STRENGTH AND CHARGE-TYPE

All of the formulas except those in the column headed 0 are to be read as *ions* with the appropriate charge. The elementary symbols refer to the hydrated ions as they exist in dilute water solution, thus Be means $[Be(H_2O)_x]^{++} + H_2O \rightleftarrows \left[Be\begin{matrix}(H_2O)\\OH\end{matrix}x-1\right]^{+} + H_3O$. The names of the alkaloids and bases, such as brucine and aniline, refer to the appropriate positive ions of the salts formed by the base as $(H^+)_2(C_{23}H_{26}O_4N_2)$, $H^+(C_{23}H_{25}O_4N_2)$ and $H^+(C_6H_5NH_2)$. The values of K_A are in general taken from data in Landolt-Börnstein, Tabellen, 5th ed. The chromium and cobalt values are due to Brönsted, the alkaline earths to Kolthoff. The effect of the electrostatic charge is especially evident in the pyrophosphoric acids, and that of structure in the homologs of water and hydrogen sulfide. "DIEA" means diethylaniline, "DIET" means diethylamine.

all-important. Of two acids with the same structure that one will be the stronger whose positive charge is higher, because it will have a greater tendency to repel protons. This could best be tested by comparing such pairs of acids as $\left[\mathrm{Co}\begin{matrix}\mathrm{H_2O}\\(\mathrm{NH_3})_5\end{matrix}\right]^{+++}$ and $\left[\mathrm{Co}\begin{matrix}\mathrm{H_2O}\\(\mathrm{NH_3})_5\end{matrix}\right]^{++}$, $HMnO_4$ and $HMnO_4^-$, or $H[Fe(CN)_6]^=$ and $H[Fe(CN)_6]^{\equiv}$, but the necessary data are not at hand. A familiar case is afforded by the polybasic acids, whose second and succeeding hydrogen ions are always liberated with decreasing readiness. Of course here the acids compared, as for example, $H_4P_2O_7$, $H_3P_2O_7^-$, $H_2P_2O_7^=$, and $HP_2O_7^{\equiv}$, are not identical in structure, but they cannot be greatly different from each other. E. Q. Adams[9] has shown that in the limiting case, where the acid molecule is so long that two acid groups are entirely without influence on each other, the tendency of the first hydrogen to leave the group is four times that of the second, and in all other cases more than four. In view of this effect of the charge we may note the series $H^+(H_2O)$, H_2O, and $H\overline{O}$, three acids of similar structure, the ratios of whose constants are undoubtedly very large.

Turning now to the effect of structure on acidity, we should compare different members of the same column in our table, that is, acids which are in the same electrical condition. As the uncharged acids form the best-known class, we will confine our discussion to them. Let us first consider the typical binary hydrides containing positive hydrogen. These are listed in Table I, and their approximate dissociation constants, where known or estimated, are written beneath them. Here the acid strength uniformly increases from left to right and from top to bottom of the table, corresponding

TABLE I

H_6B_2	H_4C	H_3N	H·HO	HF
			($10^{-15.7}$)	(10^{-2})
	H_4Si	H_3P	H·HS	HCl
			(10^{-8})	(10^{4})
	H_4Ge	H_3As	H·HSe	HBr
			(10^{-4})	(>HCl)
	H_4Sn	H_3Sb	H·HTe	HI
			(10^{-3})	(>HBr)

presumably to (*a*) decreasing negative charge on the "central" atom, and (*b*) increasing radius of the latter.

Considering next the oxygen acids; we find that as Hantzsch has pointed out, it is useful to classify them according to the number of oxygen atoms in the molecule.

The strongest of the familiar acids, such as $HClO_4$, $HMnO_4$, and $H{\cdot}HSO_4$, form the first or 4-oxygen group, and they are closely followed by the three-

[9] Adams, *J. Am. Chem. Soc.*, **38**, 1504 (1916).

atom oxy-acids, such as $HClO_3$, HNO_3, $HHSO_3$, and the sulfonic acids $HRSO_3$, but in addition to these strong members, the group also contains such weak acids as HH_2BO_3 and $HHCO_3$. The next group, the two-atom oxy-acids, includes on the one hand the relatively weak $HClO_2$ and HNO_2 and on the other, the carboxylic acids ranging in strength from pentachlorpropionic and trichloracetic to very weak members indeed. Weaker still are those acids which contain only one atom of oxygen, such as HClO, phenol, the aldehydes, alcohols, etc. Of course many substances do not fit this scheme, but there seems good evidence that, by and large, an increase in the number of such atoms as oxygen or the halogens tends to enhance the acid strength of a molecule.

Lastly we might examine the acids commonly called complex, such as HBF_4, H_2PtCl_6, $H_3Fe(CN)_6$, and H_6TeO_6. Many of these appear to be quite strong, as would be expected from their similarity to the 4-oxy acids just described.

Looking at the matter from another angle, we may compare $H{\cdot}H_3SiO_4$, $H{\cdot}H_2PO_4$, $H{\cdot}HSO_4$, and $HClO_4$. Here the principal variable is the steadily decreasing (negative) charge of the central atom, and the corresponding increase of acid strength is very marked. At a pH of 7 the preferred state of the atoms in this row of the periodic table appears to be $Na^+(H_2O)_x$, $Mg^{++}(H_2O)_x$, $[Al(H_2O)_5OH]^{++}$, $Si(OH)_4$, equimolar mixture of $H_2PO_4^-$ and $HPO_4^=$, $SO_4^=$, and ClO_4^-.

The ionic radius also has a noticeable effect on acid strength. When the ion is positively charged, small radius means high acidity. Thus $Li^+(H_2O)_xCl^-$ and $Be^{++}(H_2O)_xCl_2^-$, are much more hydrolyzed than $Na^+(H_2O)_xCl$ and $Mg^{++}(H_2O)_6Cl_2^-$. When the ion is negatively charged, on the other hand, the reverse is the case. ($H{\cdot}HO$ and HF are weaker than $H{\cdot}HS$ and HCl.)

The effect of substituent groups on acid strength has been carefully studied among the organic acids, and quantitative rules have been established by Wegscheider.[10] The greatest increases in acid strength are caused by the introduction of a chlorine atom in the alpha position in the chain of a saturated fatty acid, and by that of a nitro group in the ortho position in an aromatic acid.

The Strongest Acids

The question of the relative strength of the strongest uncharged acids, such as $HClO_4$, $HHSO_4$, HBr, HCl, HNO_3, etc., has always seemed a very interesting one to me. These acids all appear to be of practically equal strength in dilute water solution. They appear to be practically com-

[10] See for example, Creighton and Fink, "Electrochemistry," Chap. XVI, Wiley & Sons, New York, 1928.

pletely dissociated, and the hydrogen-ion activity in equally concentrated solutions of the different acids is practically the same. We may suppose, following Hantzsch and Brönsted, that this is due to the fact that in such solutions the reaction

$$HX + H_2O \longrightarrow H_3O^+ + \bar{X}$$

has run virtually to completion in all cases, so that in every case we are dealing with the same concentration of the same acid, H_3O^+. In very concentrated aqueous solutions, however, a decidedly individual behavior makes itself apparent as Hantzsch has clearly shown, and this leads to the view that in such solutions there are appreciable concentrations of the molecular acids themselves, whose individual tendencies to liberate protons account in part for the observed differences of behavior. In solvents other than water it has been shown by Hantzsch that these individualities of behavior are still more marked, and it should be possible, by a study of the individual acids in a variety of non-aqueous solvents, to form a good idea of their true relative strength. There are three principal influences affecting the apparent strength of an acid in a given solvent. The first is the *intrinsic strength* of the acid: the general tendency of its molecule to liberate protons. The constant expressing this tendency may be regarded as fixed and equal by definition for all solvents at any particular temperature. Next there is the basic strength, or protophilic tendency of the solvent, which determines to what extent the true strength of the acid can manifest itself, and finally there is the dielectric constant of the solvent, which determines the extent to which the ions, products of the reaction of the acid with the solvent, can exist independently of each other. Water is a basic solvent of high dielectric constant. The strong acids, therefore, react completely with it, and the products exist as separate ions. The acidity of dilute solutions in water can never be very high, however, because the acids are all converted into hydronium ion, whose specific proton activity is not very great.

In a non-basic solvent such as acetic acid or benzene, the acids will have combined with the solvent to a much less extent, so that the proton activities of their individual molecules may give high acidity to the solution, although because of the low dielectric constant there will be relatively few (unassociated) ions. Although it may never be possible to compare the acidities of solutions in different solvents in a completely rigorous way, it is already evident that qualitatively at least these predictions are fulfilled. Thus it may well be possible to prepare a series of solutions containing only moderate concentrations of the strongest acids in suitable solvents, whose true acidities range well into the million-fold values of those obtainable in water solutions of the same concentration. As indicators can be found which are sensitive in this range of high absolute acidity, it should be pos-

sible to develop a "pH technic" which will extend to high negative values, the ordinary pH scale running from 0 to 14.

It should be remembered that the true measure of acidity is taken to be hydrogen-ion activity as measured with a suitable electrode, and not the velocity of reaction of a solution with solid metals, carbonates, etc. These reaction velocities depend on a large variety of secondary influences, and may be inappreciable, even in very highly acid solutions.

Harrison Memorial Prize for 1929. The Harrison Memorial Prize Selection Committee, consisting of the presidents of the Chemical Society, Institute of Chemistry of Great Britain and Ireland, Society of Chemical Industry, and Pharmaceutical Society, has awarded the Harrison Memorial Prize for 1929 to Dr. R. P. Linstead. The prize is given for conspicuously meritorious work in any branch of chemistry, pure or applied, and is to be regarded as an exceptional distinction to be conferred upon a chemist less than thirty years of age who in the opinion of those best qualified to judge had made a notable addition to our knowledge of chemistry. The presentation of the prize will be made at the annual general meeting of the Chemical Society on Mar. 27th.—*Nature*

Structural Alterations on Royal Institution. It is satisfactory to learn that the structural alterations lately decided upon at the Royal Institution are going forward with a minimum of delay, so that the amenities enjoyed in normal times by the general body of members are within reasonable distance of renewal. Further, that these alterations are so designed that the aspects and qualities of the historic rooms and of the theater are being carefully preserved. We trust, as do many who hold the Royal Institution in deep regard, that in the end that old-time atmosphere, that flavor of great personal traditions which here appeals so strongly, will be found not entirely disconnected with the efforts of rehabilitation. If any doubt existed as to the advisability of reconstructing the theater, it has been removed during the dismantling of the structure by the disclosure of the dangerous condition of the woodwork. In the course of a century, dry-rot had obtained a hold in many parts.

The financial problems arising from the various alterations to the Royal Institution are, of course, extremely onerous. Although those whom we may perhaps call the friends of the Royal Institution have generously responded to a first financial call entailed by the scheme, a balance of about £17,000 is still required. The Royal Institution with its laboratory, fine library, and rota of experimental and philosophical lectures, is something beyond a mere London Society of persons interested in the movements and progress of science. In effect it is a bequeathment to posterity by Rumford, Davy, Faraday, Dewar, the repercussions of which are international. Accordingly, strong hopes are entertained that the necessary sum will be forthcoming. Apart from physical science it is worth recalling that the Royal Institution in early days took a hand in the promotion of geology and mineralogy. By the year 1804 a museum of more than 3000 mineral specimens and fossils had been brought together, including a special collection of minerals formed by Davy. During the years 1805–07 Davy lectured occasionally on geology as well as chemistry, and he was one of those present at the meeting in Freemason's Tavern, Great Queen Street, on Nov. 13, 1807, when it was resolved to institute a Geological Society. Faraday became a member of the Geological Society in 1824.—*Nature*

THE PEANUT INDUSTRY. I. PEANUT CULTURE*

D. F. J. LYNCH, BUREAU OF CHEMISTRY AND SOILS, U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

Name and Origin of Peanut

In the literature of the past century the peanut is encountered under a host of names. To enumerate the majority, if not all the names that this plant has enjoyed, there are the Earth or Ground Nut, the Pig Nut, the Ar-Nut, the African Nut, the Kipper Nut, the Hawk Nut, the Jar-Nut, the Earth Chestnut, the Monkey Nut, the Manilla Nut, the Chinese Nut, the Gober Pea or Gober Nut or in southern United States Goober Nut, the Pindar, the Pistasche de Terre, and l'Arachide.[1] Botanically it is known as Arachis *hypogaea*. Pliny gave the name Aracos, Aracidna, or Arachis to a plant which had neither leaves nor stem, consisting wholly of root. Modern botanists have, however, given the name Arachis to a species of plant which ripens its fruit underground.[2]

The Arachis *hypogaea* is unknown in the wild state and there is some uncertainty concerning its country of origin, although it is generally considered to have come from tropical America. A. de Candolle in the "Origin of Cultivated Plants,"[3] states that the peanut is a native of Brazil. That the peanut was an important article in the diet of the early Indians of South America is very definitely shown by W. S. Safford in his article, "Our Heritage from the American Indians."[4] In the great prehistoric cemetery of Ancón, on the coast of Peru near Lima, in a large number of graves seated mummies were discovered surrounded by terra cotta jars containing various foodstuffs among which the peanut was conspicuous. It was further north along the same coast, near Trujillo and Chimbote, Mr. Safford says, that terra cotta funerary vases were found, covered in relief with peanuts. There is one beautiful specimen of these terra cotta funerary vases in the American Museum of Natural History in New York and another specimen in the National Museum in Washington (see illustrations 1, 2, and 3) which show by the incorporation of the peanut into their decorative art the esteem in which these early people held the

* Acknowledgment is here made to W. R. Beattie, Horticulturalist, Bureau of Plant Industry, for the use of cuts from the U. S. Dept. of Agriculture *Farmers Bull.* No. 1127; to Harold J. Clay and Paul M. Williams, Marketing Specialists, Bureau of Agricultural Economics, for use of cuts from U. S. Dept. of Agriculture *Bulletin* No. 1401; and to Harold J. Clay for criticism of the manuscript.

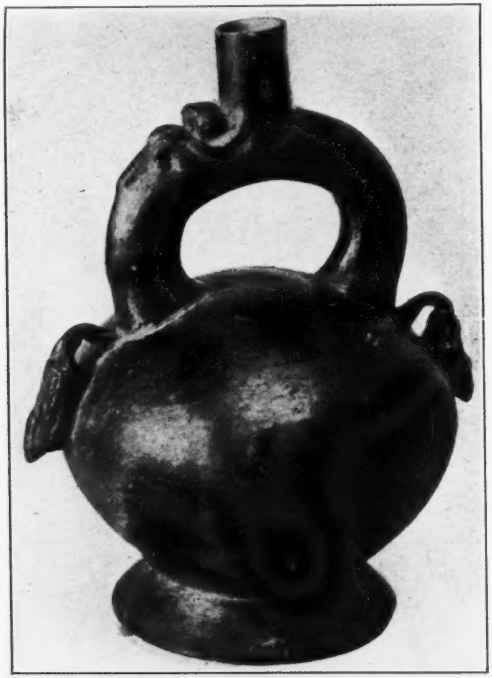
Photographs for illustrations 1, 2, and 3 were loaned us by C. G. Abbot, Secretary, Smithsonian Institution.

[1] Encycl. Brit.

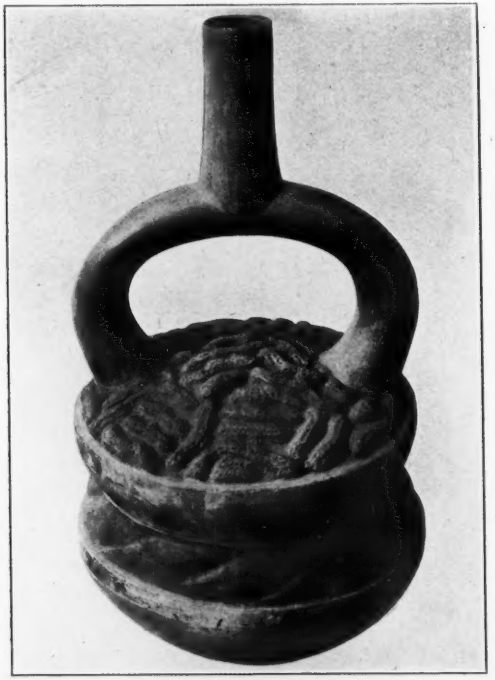
[2] Chamber's Encycl.

[3] Pp. 411–5, Kegan, Paul, Trench, and Co., 1 Paternoster Square, London, England (1884).

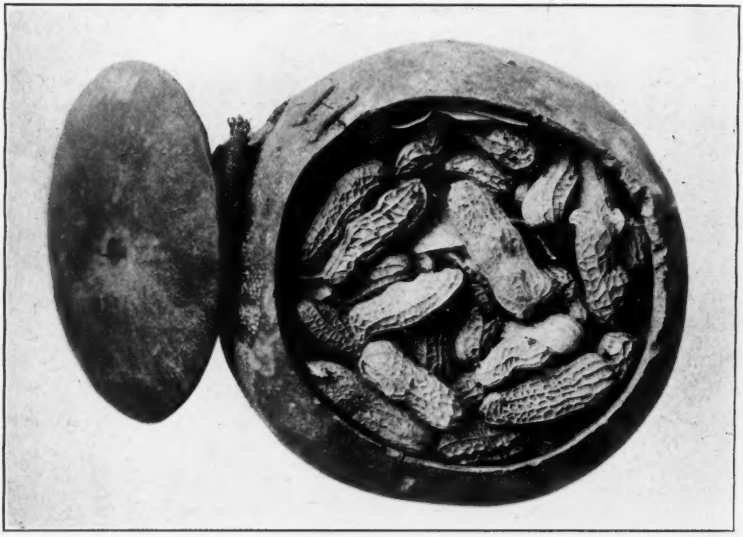
[4] *Annual Report of the Smithsonian Institution* for the Year Ending June 30, 1926.



FUNERARY VASE OF BLACK CLAY, DECORATED WITH TWO PEANUTS. COAST OF PERU. NATIONAL MUSEUM, WASHINGTON



FUNERARY VASE DECORATED WITH PEANUTS. COAST OF PERU. AMERICAN MUSEUM OF NATURAL HISTORY. NEW YORK



PEANUTS (*Arachis hypogaea*) IN A CALABASH. FOUND AT ANCÓN. NATIONAL MUSEUM, WASHINGTON

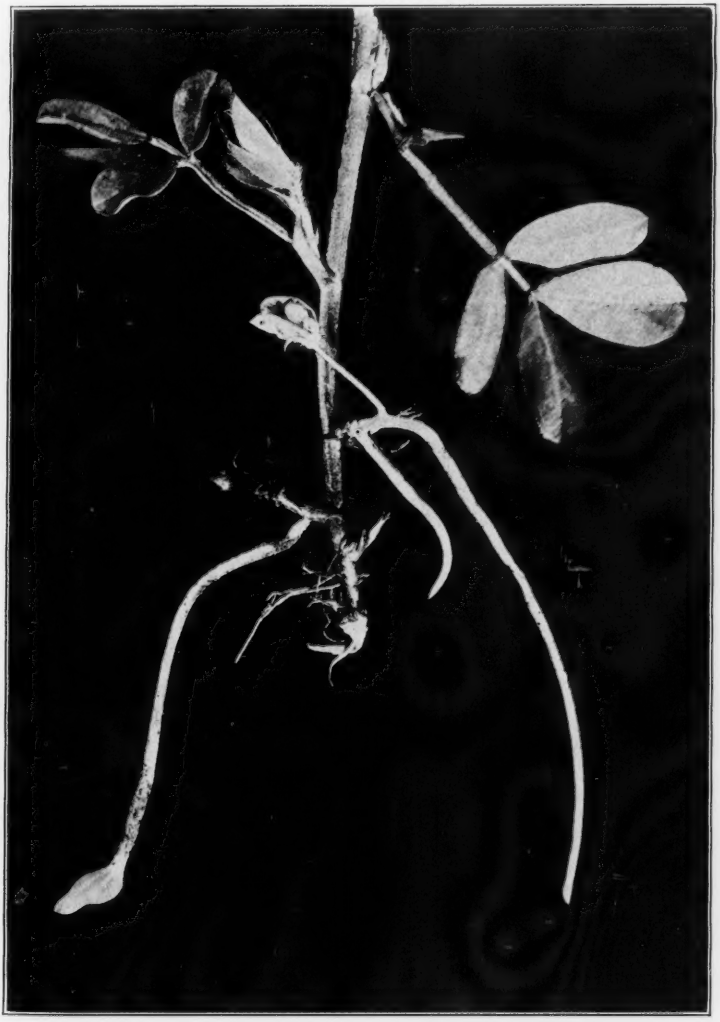
Arachis *hypogaea*. Several species of the genus Arachis grow spontaneously in Central America, but the peanut has been so improved by cultivation that they are no longer comparable with it.

From America the peanut is reported to have been taken to Africa in the early slave ships and there the great value of the peanut was soon recognized and its culture started. For a long time the peanut was supposed to be of African origin and it received many of its names in Africa, from visiting European traders. The native Africans found the peanut palatable and this fact led to its inclusion in the ship stores of the slave traders, and along with the slaves the peanut was introduced into our South during the colonial times. For many years, however, the peanut was little known outside of Virginia, North Carolina, and Tennessee, where it was cultivated to a small extent. During the Civil War the peanut became popular with both armies and the appreciative information concerning the peanut which the demobilized Union soldiers carried to all parts of this country gave the first important impulse to the culture of the peanut in the United States.[5]

The Peanut Plant

The peanut is an annual herbaceous plant belonging to the *Papilionaceae*, a sub-order of the larger natural order *Leguminoseae*. The hairy

[5] *U. S. Dept. Agr. Bull.* **1401.**



Peanut Flower and the Pegs That Form Pods

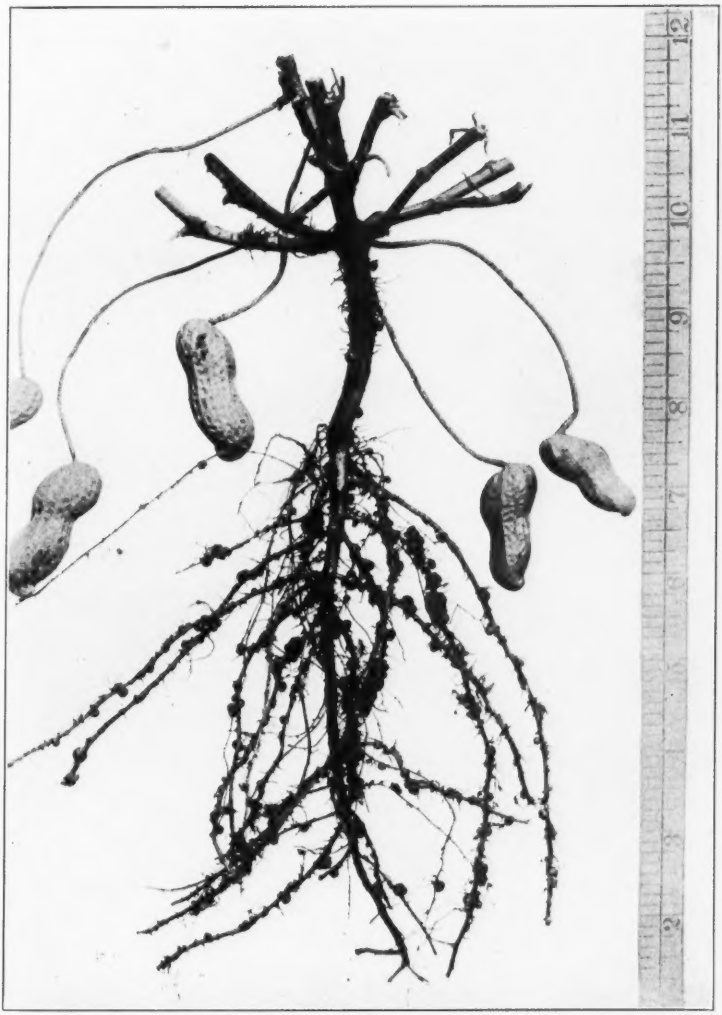
stem of the plant grows to a length of from one to three feet and sprouts pinnate leaves similar in appearance to the clover, but these leaves are formed by four leaflets. If of the Spanish variety, the stem stands erect, but the Virginia Runner type trails along the ground. There exists also the type known as the Virginia Bunch. Before the leaves sprout, yellow sterile flowers appear on the stem and soon die. Later the plant bears another crop of smaller flowers which are nearly hidden by the foliage. These flowers are, at first, sessile, having no peduncle or flower stalk, but the tubular calyx which encases the ovary is often three-quarters of an inch long and is, therefore, sometimes mistaken for the flower stalk. After fertilization the true peduncle develops and grows to several inches in length to reach the soil and push the ovary three or four inches below the surface. It is necessary that there be a fine surface tilth on the soil so that the delicate flower stalk bearing the ovary may penetrate the soil, because if the peduncle doesn't get the ovary below the soil surface, neither seeds nor pods are formed. The pods are oblong, roughly cylindrical, and about one inch long, containing usually two irregular ovoid seeds. The roots of the peanut, like many leguminous plants, have nodular growths, due to the action of nitro-bacteria, which have the power of fixing the free nitrogen of the atmosphere, rendering it available for the plant, and thus improving the soil.[6]

A light sandy soil with no excess organic matter or excessive coloring matter should be chosen for peanut culture. No nitrogen fertilizer is required, but the addition of about one thousand pounds of lime per acre reduces the number of "pops" in the crop. Today the peanut is extensively cultivated in the tropical and sub-tropical countries. With a period of five months without frosts the peanut is very prolific, yielding 30 to 60 bushels of nuts to the acre, and yields of 100 bushels to the acre have been recorded. The average yield over the whole county has, however, declined from about 34 to about 28 bushels.[7]

In this country today there have been developed nine varieties of peanuts, showing sufficient definite characteristics to be separately classified. Five varieties, although popular with the growers in limited fields, are commercially unimportant. In this group are the Improved Spanish, a strain of the white Spanish and sold under that name; the Valencia, grown around Wakefield, Virginia, and in a limited way in Virginia, North Carolina, and Tennessee; the Tennessee Red Skin and the Tennessee White Skin, which are grown in parts of Tennessee and Georgia, and the African or Wilmington, which comes from the neighborhood of Wilmington, N. C. The important varieties are known as the Virginia Bunch, Virginia Runner, Jumbo, all large podded, having a nut with a reddish

[6] *Bull. of the Imp. Inst.*, **8**, p. 154.

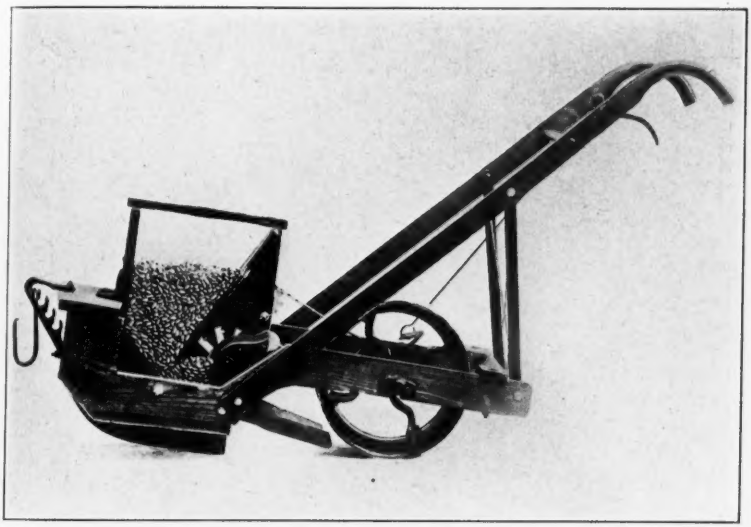
[7] Yearbook Dept. of Agriculture, **1927**.



ROOTS OF A PEANUT PLANT, SHOWING NODULES FORMED BY THE BACTERIA WHICH COLLECT NITROGEN

VIRGINIA BUNCH PEANUTS

SPANISH PEANUTS



A One-Horse Peanut Planter

skin; the Southeastern Runner which has a dark red-brown skin; and the White Spanish. The first three have been developed from one plant. Those plants among the Runners showing a bunch habit of growth were segregated and from those plants was developed a distinct variety known as the Virginia Bunch, which is generally larger than the procumbent Runner.[5] From selected strains of large size Runners and Bunch there has been developed the Jumbo variety. This Jumbo variety should not be confused with the jumbo grade which is a trade grade or class consisting of all the large size nuts of all three Virginia varieties. These three varieties are grown in Virginia, northeastern North Carolina, and in central Tennessee. The Southeastern Runner is cultivated in the southeastern part of this country with large yields. The flavor is not considered desirable in food products and it is used for the production of peanut oil. The variety known as the White Spanish peanut is grown from Virginia to Texas, this plant grows erect and is easy to harvest. Its pods are smaller than the Virginia and the skin covering the nuts is brown rather than red. As farmers' stock all of these varieties of peanuts come to the market as Virginias, Runners, or Spanish nuts.

Peanut Culture and Harvesting

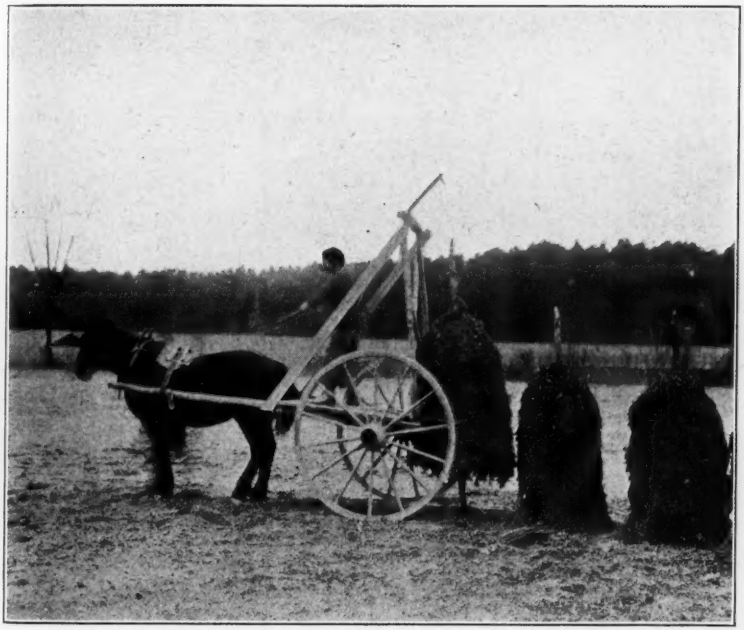
Before the planting the earth should be flat broken to a medium depth and the soil thoroughly pulverized with disc and smoothing harrows.

Potato Digger Used for Digging Peanuts

Poles Around Which Stacks of Peanuts Are to Be Built

PARTLY COMPLETED STACK OF PEANUTS, SHOWING THE METHOD OF PLACING THE VINES IN STACKING. COMPLETED STACKS ARE SHOWN IN THE BACKGROUND

TYPICAL STACK OF PEANUTS AT THE TIME OF COMPLETION AND BEFORE IT HAS SETTLED. PRACTICALLY NO PODS ARE EXPOSED TO THE WEATHER



DEVICE USED FOR LIFTING PEANUT STACKS AND MOVING THEM TO THE PICKER IN THE FIELD

Into the rows, which should be two and one-half to three feet apart, either the shelled nuts or the nuts in the shells should be dropped every ten or twelve inches.[8] The peanut grower in the tropic prefers to plant the nuts in the shells for protection from the birds but in this country the nuts are shelled before planting. If nuts in the shells are to be used the pods are usually soaked in water for 36 to 48 hours preceding the planting. Most of the planting today is done by a machine, the peanut planter, which has greatly reduced the cost of this operation. The cost of cultivation has also been reduced by the use of the weeder and large cultivating implements. The usual practice is to destroy the weeds by running the weeder over the field just before the plants come up and again just after they appear, and in this way allow the peanut plants to get ahead of the weeds.

In like manner there have been many improvements in the harvesting of the crop. From the early method of pulling up the plants by hand we have progressed through the practice of using the ordinary plow with a

[8] *Miss. Agr. Expt. Sta. Bull.* No. 130.

OLD-FASHIONED METHOD OF PICKING PEANUTS FROM THE VINES BY HAND

so-called peanut point and with the mold board removed, and through the use of the potato digging machine, to the special peanut digger. These machines, in addition to lifting the plant, shake off most of the soil and leave the plant lying on the surface of the ground. Most peanuts are, however, still "plowed out." The plants are usually allowed to wilt on the ground for six or seven hours, and are then stacked for curing.[9]

Much care is taken in the stacking and curing of the peanut, because, regardless of the nuts, the farmer has in the vine a valuable stock food. Seven foot stakes are firmly set in the ground and the vines are stacked around these stakes with the pods to the center. Cross pieces are nailed to the stake at about eight inches from the ground to keep the nuts off the damp earth and to provide ventilation up the middle of the stack. To protect the stack from rain it is capped with dry grass. The curing usually takes from four to six weeks.[9] In dry weather, however, curing can be accomplished in less time while at other times the peanuts may remain in the stacks a couple of months before picking. If the nuts should be picked from the vines before the necessary curing the kernels may shrivel up. In China much less time is allowed for curing.

The next step, the separation of the pods from the vines, was formerly carried out wholly by negro hand labor. For the small Spanish variety

[9] *U. S. Dept. Farmers Bull.* **1127.**

A Commercial Peanut Picker in Operation

The pile at the left of the picture consists of vines and foreign material remaining after the pods were picked. The bags in the foreground contain the peanuts. The lumber at the extreme right is a portion of the stakes around which the vines were stacked and which are not usually removed until the stacks are brought to the picker.

grain-threshing machines with a special cylinder were later adapted to this task and these machines are in general use in the southwest. With care, a good separation of pods and vines can be accomplished by these machines with the Spanish peanut.[10] Large podded Virginias, however, fare badly in this type of machine. Patented pickers have, therefore, been adapted for this work in the Virginia-North Carolina field. In these pickers the vines are dragged over a horizontal frame on which there is a wire netting. Springs separate the vines, the pods catching in the wire netting are removed and an endless belt conveyor removes the vines. There is also a fan attachment for blowing off the trash that adheres to the pods. Today many of these efficient patented pickers are used with the Runners and Spanish nuts as well as with the Virginias. The pods are usually packed directly from the picker into 4-bushel bags, which average 88 pounds of Virginia stock and 120 pounds of Spanish stock. In the trade the peanuts at this point are known as *farmer's stock*.

Carelessness on the part of the operators of these picking machines, who are tempted to speed up the machine, due to the fact that they are paid according to the number of sacks of peanuts picked, cause considerable breakage of pods and kernels, thus increasing the percentage of splits, or No. 2 peanuts. The kernels in the cracked pods often become moldy and rancid. Well-cultivated crops of peanuts seem to be attacked by few, if any, pests. In the fields rodents and some birds will attack the freshly planted seeds and tender sprouts. A root aphis has also been detected in this country, but so far it seems to have done little harm to the crop. In the warehouses, however, weevils are liable to attack the peanut, but they can do no damage to the sound pod, for it is practically impossible for the weevils to penetrate it. Kernels in broken pods or shelled nuts, however, suffer considerably in the warehouses from the ravages of the weevils.[6]

To this practical freedom of the peanut plant from insect pests and plant diseases, together with the rapid advance of the boll weevil from Texas eastward through the cotton belt with its ruinous effect on the cotton crop, is due the most rapid growth in peanut culture in this country. The cotton farmers of Alabama, Georgia, Florida, and Texas turned to the peanut because it offered a ready market at the peanut shelling and crushing mills, and good cheap food for their hogs. This boom in peanut culture swept Texas, Georgia, and Alabama, increasing the peanut acreage, causing the establishment of shelling plants and crushing mills, and in this way bringing business to the cottonseed crushers who, with slight changes in their machinery, were rather well equipped for the production of peanut oil.[5]

[10] *U. S. Dept. Agric. Office Sec. Circ.* **81.**

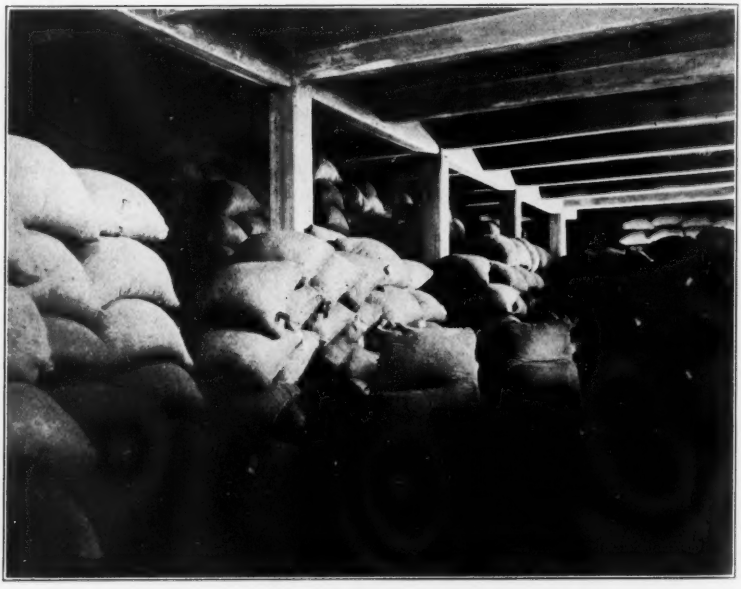
"Hogging Off the Crop"

There is, however, a large part of the peanut crop which goes neither to the crushing mills nor to the shellers, in fact this portion of the crop is never harvested. When these peanuts ripen in the fall the fields are opened to the pigs and these peanuts are "hogged off." It has long been considered that a substantial part of the crop was disposed of in this way, but the tables in the Crop Report of December 15, 1928, of the Bureau of Agricultural Economics, U. S. Department of Agriculture, are the first published statistics which give us exact information on this point. From the two tables on peanuts listed in the Crop Report, one called Total Production and the other Peanuts, which table includes only that part of the crop actually gathered or harvested, we find that for the year 1927 of a total acreage of 1,785,000 acres, 643,000 were "hogged off," and in 1928 the peanuts grown on 728,000 acres of the total 1,909,000 acres were utilized in the same manner. About fifty per cent of the crop of Georgia, Alabama, and Arkansas were used for hog food. Of the total estimated production of 1,311,793,000 pounds in 1927, 864,549,000 pounds were gathered and 447,244,000 pounds were used to fatten the hogs of the South, while in 1928, of a total crop of 1,230,390,000 pounds 809,060,000 pounds were harvested, leaving 421,330,000 pounds which were consumed by the hogs. (It will be noted that the latest revised figures for the 1927 and the 1928 crops have been used, which figures just reverse the earlier estimates. The new estimates increase the older 1927 estimate from about 800,000,000 pounds to 860,000,000 pounds, and they also reduce the older 1928 figures from about 860,000,000 pounds to 809,000,000 pounds.) Accepting the yearly average price for the gathered nuts as a basis for computing the value of the nuts consumed by the pig-raising industry of the South we obtain the amounts $17,790,000, and $19,188,864 for the years 1927 and 1928, respectively.

Disposal of Farmer's Goods

It is in that part of the peanut crop which is gathered, however, that the interest of most of us is centered. From the December 15th Crop Report we have seen that this portion—farmers' stock—amounts to from 60 to 65 per cent of the total. From the marketing specialists of the Bureau of Agricultural Economics we receive the information that by January 70–75% of the farmers' stock of the crop is out of the hands of the Virginia farmers.[11] It is interesting to ascertain where these peanuts go as well as why, in such a short time after the harvest, the farmer retains little of his

[11] "Historical Study of Prices Received by Producers of Farm Products in Virginia (1801–1927)," A. G. Peterson. *Technical Bull.* No. 37 (Mar., 1929). Published by the Va. Agr. Exp. Sta., Va. Polytechnic Institute, Blacksburg, Va.



FARMERS' STOCK PEANUTS IN COMMERCIAL STORAGE IN VIRGINIA

The use of tags assures the owner of having his own stock returned to him or sold for his account.

crop. Like most other farmers, the peanut grower has acquired his seed, lime, and supplies, as well as defrayed the necessary labor expenses on credit. The local merchants and banks in the peanut-growing sections extend considerable credit for the production of this important crop. This indebtedness is so arranged that payment is due in November and in the early part of December, just after the harvest, and in the necessity for liquefying these debts we have the reason for the rapid sale of the crop. In return for his 1928 crop the farmer in the Virginia-North Carolina section received, during the week of December 12th, for his Jumbos 5 to $5^1/_2$ cents a pound; his peanuts of the Bunch variety brought $4^3/_4$ to $5^1/_4$ cents a pound; his Runners sold for $4^1/_2$ to $4^3/_4$ cents a pound, and his Spanish Farmers' Stock brought him \$1.25 to \$1.30 per 30-pound bushel.[12]

Some of this huge crop is purchased by country shippers and speculators, but naturally they turn their purchases over to the cleaners and shellers who also buy independently. Regardless of who buys these peanuts, they cannot be resold immediately to the consumer. There must be some method of holding the peanuts off the market, and supplying this

[12] December 12th Weekly Peanut Report.

food product as demanded, for the orderly conducting of this business. As in the case of many another food article the peanuts must be stored in a warehouse. Some prosperous farmers store their stock on their own farms and, if they can afford to wait a few months, may secure an adequate return for this added trouble.[13] There is, however, the necessity of some care in the storage of the nuts. The warehouse must be dry and well ventilated and, of course, free from rats and mice. As mentioned above, shelled nuts and nuts in broken pods are very susceptible to the attack of weevils, while in storage. As in the case of similar products most of the peanut crop is stored in commercial warehouses. Under the United States Warehouse Act of September, 1923, peanuts were included as a storage product. This act is administered by the U. S. Department of Agriculture. Those owners who store goods in the warehouses licensed under the act are protected from loss. At the time of storage the owner receives a standard warehouse receipt, negotiable in form, which is accepted by banks generally as collateral for loans. From the warehouse the farmers' stock is withdrawn as it is sold to and needed by the cleaning and shelling plants.

[13] *U. S. Dept. Agr. Bur. Plant Ind. Circular* **88.**

What Freshmen Do with Time Discovered. Approximately eighty per cent of the average college freshman's time is spent in eight activities, according to Dr. Richard S. Uhrbrock of the Course in Hotel Administration at Cornell University, speaking recently before the Section on Education at the meeting of the American Association for the Advancement of Science. These activities, in order of time occupied, are sleeping, attending classes, studying, eating, working for pay, walking, physical exercise, and "bull sessions." For the benefit of the uninitiated, the last named may be described as periods of informal conversation in which the undergraduates discuss every subject under the sun. These sessions usually are held in students' rooms, or in fraternity houses. Faculty members are seldom present.

In a study of the distribution of time for one week, made by Dr. Uhrbrock at Cornell, it was found that the typical college freshman spends approximately one-third of his time in sleep, one-third in work activities, and one-third in social, play, and personal pursuits.

When students who made high grades were compared with those who were failing, it was found that the high scholarship men had the following general characteristics. They spent *more* time in class attendance; studying at home; in library work; on class and fraternity committees; writing reports and themes; walking or riding to and from classes; in remunerative work; reading newspapers, magazines, novels; on family duties; listening to visiting lecturers; keeping record of use of time. They spent *less* time in conferences with instructors; in physical exercise; attending movies, plays, and concerts; on parties, dates, and dances; card playing; automobile riding; "bull sessions;" shopping; telephoning; at meals; bathing, shaving, dressing; sleeping.—*Science Service*

THE CHARLES JAMES HALL OF CHEMISTRY OF THE UNIVERSITY OF NEW HAMPSHIRE

HAROLD A. IDDLES, UNIVERSITY OF NEW HAMPSHIRE, DURHAM, N. H.

Historical

The teaching of chemistry in the University of New Hampshire began in 1868, soon after the establishment of the College at Hanover, although at that time it was confined more especially to the field of agricultural chemistry.

In 1892 the College moved to its present location in Durham. By this time the work in chemistry had expanded so that a separate building, Conant Hall, was erected at a cost of $40,000 to house the activities of the department. Under the Professorships of Charles L. Parsons and more recently of the late Charles James, the department expanded and developed so that entirely new and larger quarters became necessary. It was to fulfil this need for modern teaching facilities and adequate research space that the present building was planned and erected.

Charles James

Probably no one is better able to furnish us information concerning the man under whose capable guidance this chemistry department was for the past twenty years and in whose honor this new structure was dedicated than Dr. Charles L. Parsons.[1]

Charles James was born April 27, 1880, at Earls Barton near Northampton, England. He studied with Ramsay at University College, and graduated from the Institute of Chemistry in 1904, becoming a Fellow in 1907. He came to the United States in 1906 and was first employed as a chemist for the National Refining Co., going the same year as instructor to New Hampshire College, being promoted to full professor in charge of the department in 1912, and receiving from the University of New Hampshire the honorary degree of doctor of science in 1928.

Doctor James was a member of the American Chemical Society, The Chemical Society (London), and Alpha Chi Sigma. He was awarded the Ramsay silver medal in 1901 and received the Nichols medal in 1911. He was the author of over sixty papers published in the *Journal of the American Chemical Society*, chiefly in the field of the rare earths. He also contributed to many other scientific chemical journals and wrote the articles on rare earths and metals for the last edition of the "Encyclopedia Britannica."

Except for the very retiring nature of Professor James, he would have held many positions of honor and would have received far more recognition than was his lot. His work and his friendly helpful nature deserved it. He preferred to stay in his laboratory, often until late at night, or work among his flowers rather than attend meetings or make new acquaintances. A few in the Northeastern Section, whose meetings he did attend, and those of us who were fortunate enough to come in close contact with him personally, have lost a sincere friend who was always a pleasant companion as well as an inspiration. He was devoted to flowers and preferred a vacation among the orchids of Honduras, or the like, to any other relaxation. His home was surrounded with delphiniums, in which he specialized. His income was divided between building green-

[1] *Ind. Eng. Chem., News Ed.*, **6**, 5 (Dec. 20, 1928).

The Late Professor Charles James, 1880–1928

houses and flower beds and the purchase of rare minerals, almost from the ends of the earth, to furnish the rare earths to which his professional life was devoted. With the rare earths he worked with kilograms, where others have dealt in grams. He left a large, important, and valuable collection in Durham, besides furnishing quantities to others for their researches. It is doubtful if there is anywhere in the world a more complete collection of the rare earths than he left in Durham. It is to be hoped that some one of his pupils, and some one who is thoroughly competent, will make it a labor of love to see that they are carefully preserved and labeled. Many of them have been separated to a degree of purity not before accomplished.

The writer remembers distinctly that at the time the discovery of lutecium was announced from France, Professor James was about to publish his own discovery of the element on which he had been working for months, and of which he had accumulated a large amount. He would have published the results of his discovery sooner save for his determination to print no statements that had not been verified. The announcement of the discovery by another was a natural disappointment to him, but only one or two of his associates ever knew of the fact. The publication having been made and being correct, he accepted it without question and made no claim whatever for his own work. So far as the writer is aware, his publications have never been questioned by those in the same field.

When the discovery of illinium was announced, he had spectrographs showing the lines but did not consider himself justified in publishing the discovery. The situation was much the same with him as it was in the case of lutecium, except that with lutecium he had in hand a much larger quantity of the highly purified material.

Doctor James possessed an unusual technic in preparing large quantities of rare metals. He prepared rubidium, cesium, lithium, uranium, and beryllium compounds in considerable quantities for other research laboratories in this country. His aid will be missed by many who had the good fortune to know him.

Doctor James was always referred to as "King" James by his students and associates. In fact, he was more frequently addressed by this nickname than by his own. Those who had the privilege to study under him and those who were associated with him, as was the writer for some years, will all acknowledge the inspiration they received from his companionship and his knowledge, and will long remember a friend who cannot be replaced.

Dedication

On November 9, 1929, nearly four hundred members of the Northeastern Section of the American Chemical Society and other guests of the University attended the dedication of the Charles James Hall of Chemistry. The morning program was held in Murkland Auditorium with President Edward M. Lewis of the University presiding, and included the following addresses.

"Charles James—Teacher," DR. LESTER A. PRATT, Director of Research, Merrimac Chemical Co.

"Charles James—Chemist," DR. IRVING LANGMUIR, General Electric Co.

"The Relation of Chemistry to Agriculture and Biology," DR. HENRY G. KNIGHT, Chief of Bureau of Chemistry, U. S. Dept. of Agriculture.

"The Laboratory—The Key to Progress," DR. CHARLES L. PARSONS,[2] Secretary of the American Chemical Society.

[2] This address will be found on page 821 of this issue.

Charles James Hall of Chemistry at the University of New Hampshire
Dedicated on November 9, 1929.

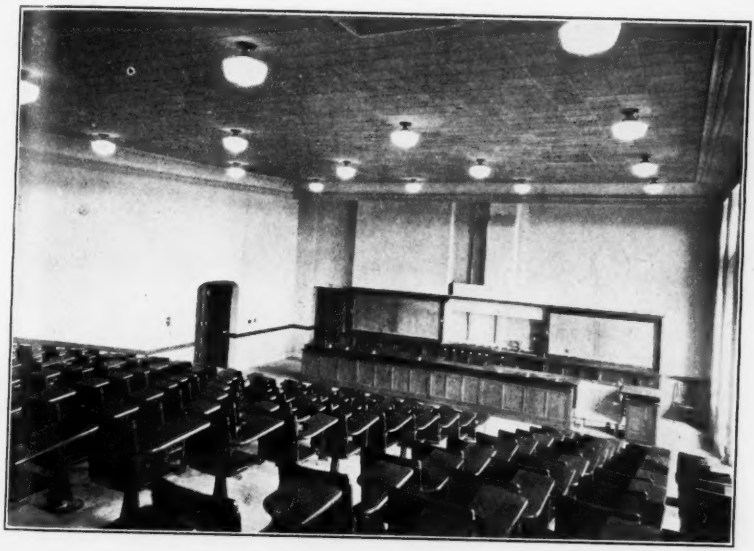
In the afternoon, the regular monthly meeting of the Northeastern Section was held in the chemistry lecture room. Dr. Irving Langmuir spoke on "The Chemical Reactions Produced by Heating Tungsten Filaments in Gases" and Professor Worth H. Rodebush of the University of Illinois spoke on "The Magnetic Properties of the Rare Earths and Other Transition Metals."

The following is a brief abstract of this address written by W. H. Rodebush:

At one time the man who did research upon the rare earths was regarded with good-humored indulgence by his colleagues. The rare earth group was commonly supposed to be a group of elements without practical importance and of monotonous chemical behavior. The investigation of the magnetic susceptibility of the rare earth ions showed that this monotony does not extend to the physical properties and with the development of our knowledge of atomic structure the rare earth group has become the most striking example of the brilliant achievements of the new physics. The peculiar properties of the rare earth ions are due to the fact that the external shell or group of electrons for each ion is the same, a group of eight electrons such as characterizes the outer group of the inert gases such as argon. The difference in the rare earth ions is to be found in the uncompleted fourth shell of electrons lying beneath this outer fifth shell. The number of electrons in the uncompleted shell is different for each element. The outer inert shell insulates the inner shell so completely from external influences that the situation is comparable to atoms in the gaseous state and a remarkably simple behavior results. La^{+++} has 18 electrons in the fourth shell, Ce^{+++} 19 and so on, Lu^{+++} completing the groups of 32. Each electron added after La^{+++} contributes to the magnetic moment of the ion in two ways, through its orbital motion and through its spin on its own axis. By combining the spin and orbital motions according to the well-established rules of the quantum theory, Hund has succeeded in predicting with astonishing success the values for the magnetic susceptibility of the ions. La^{+++} has no electron to contribute to the moment and in the case of Eu^{+++} and Lu^{+++} the electron magnetic moments neutralize each other so that the curve for magnetic susceptibility shows two maxima and is very irregular. The ions of neighboring elements differ markedly in susceptibility from each other so that the possibility exists of a separation either directly in an inhomogeneous magnetic field or by some other property which in turn depends upon magnetic susceptibility.

At low temperatures some of the rare earth salts as gadolinium sulfate octahydrate would show a very high magnetic susceptibility and a large temperature coefficient for this susceptibility. The temperature coefficient indicates that there is a reversible heat effect accompanying the processes of magnetization and demagnetization. It occurred to Debye and Giauque independently that this effect might be used as a means for getting temperatures below the boiling point of helium. The processes of magnetization and demagnetization of the salt would take the place of the compression and expansion of the fluid in the ordinary refrigeration cycle and the nearer to absolute zero the higher the efficiency of the process. It may be predicted that many interesting uses will be made of the high magnetic susceptibility of some of the rare earth salts.

A display, illustrating the work which had been carried on by Professor James and his students, was of especial interest to the visiting chemists. It was arranged to illustrate the various minerals which had been used as the source of supply of the rare earths and many beautifully colored and



MAIN LECTURE ROOM

LIBRARY

highly purified salts of the rare earths together with a typical series of crystallizations which illustrated the successive steps in a crystallization process.

Description of Building

The building consists of a main portion containing four floors, in which the work of the department of chemistry is given, and a wing having three floors in which the work of the Experiment Station and agricultural and biological chemistry is carried on. The architecture is Georgian and is in harmony with other recent buildings which have been constructed on the University campus.

The main lecture room has a seating capacity for 170 and contains a well-equipped demonstration table, a hood located just back of the table and a ventilating system in which the warmed air is drawn through openings beneath each seat and removed through ducts in the ceiling. There is a projection room in the rear and a preparation room connecting. In addition, there are four classrooms in other portions of the building which accommodate smaller groups.

As a unit of the department, a well-lighted room has been designed for the library. This room contains the texts in chemistry and a generous supply of bound journals and is in charge of a librarian.

On the ground floor are two laboratories of organic chemistry, accommodating 60 and 36 students, combustion rooms and balance room, several research rooms and special rooms for the work in rare earths, such as grinding and crushing rooms, an evaporation room, furnace room, crystallizing room and spectrograph room together with space for the general stores.

The first floor contains the departmental offices, laboratories of physical chemistry, of agricultural chemistry (96 students), of biological chemistry (32 students), and several research rooms. On the second floor are the general analytical laboratories in qualitative (118 students) and quantitative analysis (60 and 48 students), a balance room, and the rooms devoted to the work of the experiment station which include six private laboratories opening from a general utility laboratory, a dark room, a Kjeldahl room and an animal room. The laboratory for general inorganic chemistry on the third floor has lockers for 560 students. It is lighted on three sides and has a store room opening directly into the laboratory. Scattered throughout the building but located near their respective teaching laboratories are offices and private research laboratories for each member of the staff. On the top floor is a large club room which has been fitted for a lounging and smoking room for the students majoring in chemistry.

In the following a few special details have been chosen for especial mention. The building is supplied with both high- and low-pressure steam, the former for hot plates in many of the laboratories and for the distilled water

A RESEARCH ROOM

LABORATORY FOR GENERAL INORGANIC CHEMISTRY

still which is located on the top floor and supplies distilled water through block tin pipe to all of the laboratories; the latter for hot water mixers and steam-baths principally in the organic laboratories.

The electric service consists of lines for a. c. and d. c. current. There are three d. c. generators supplying 200, 110, 25 volts and twelve storage batteries all of which are controlled from a main switchboard in the machinery room. An automatic telephone system connects the various parts of the building.

The laboratory equipment consists of oak desks with chemically treated, heavy birch tops. The woodwork is also a light oak and the walls a very light buff making the whole effect a light and pleasant one. The floors are covered with rubber stone tile in the laboratories and with terrazzo in the corridors. To aid in the acoustical properties of the lecture rooms and corridors, the ceilings have been covered with "Celotex."

Memorial Tablet

The efforts of the men associated with Professor James in the planning and erection of the building, Professor E. T. Huddleston from the Architecture Department of the University, and Professor T. G. Phillips of the Agricultural Chemistry Department have been well rewarded in the completed building. To the memory of Professor James who died in December, 1928, just as the structure was beginning to rise, his former students have erected in the main corridor a memorial tablet which bears the following inscription.

CHARLES JAMES SC.D. F.I.C.
PROFESSOR OF CHEMISTRY
IN THIS UNIVERSITY 1912–1928
IN WHOSE MEMORY
THIS BUILDING IS DEDICATED
AN INSPIRING TEACHER AND EMINENT
CHEMIST, WHO ACHIEVED
BRILLIANT AND MASTERFUL RESEARCHES
THAT THE HIDDEN TRUTHS OF SCIENCE
MIGHT THE BETTER
SERVE HUMANITY.

This Tablet
Is the Gift of His Students
November 9, 1929.

"The test of true education is not what schooling does for the student, but what the student does for himself. Teachers provide his mental tools, but only he can decide how well he may use them."—*Collier's*

THE LABORATORY—THE KEY TO PROGRESS[1,2]

CHARLES L. PARSONS, MILLS BUILDING, WASHINGTON, D. C.

Webster defines a laboratory as "a place devoted to experimental study in any branch of natural science." There can be no "experimental study" without skilled workers and modern equipment. All three are integral parts of the laboratory of today—"Useless each without the other."

Human learning began with thought. Thought was aided by observation and experience. For ages discovery was largely accidental. Teaching was the transfer of new or accumulated thought from philosophers to their pupils. Progress depended on reason and imagination. For centuries universities were little more than places for monastic discussion of theories. Teaching was in reality a "Mark Hopkins on the other end of a log."

Very gradually the method changed. Man began to study facts. From observation of facts new reasoning developed. This led to the necessity for new data and this, in turn, to experimentation. Experimentation required new facilities and the laboratory was gradually born. Only facts lead to correct judgment—a principle too little recognized. "The smallest fact," said Huxley, "is a window through which the infinite may be seen."

Real laboratory procedure began little more than one hundred years ago when Boyle and Lavoisier brought exact measurement to bear, with control of conditions and reproduction at will. With these the possibility of reasonable hypothesis and correct conclusions were born. Coincident therewith came unprecedented acceleration of human progress so that it has been correctly said, "Man has made greater advancement in the last hundred years than during his whole previous existence." It may as truthfully be claimed for the last fifty years—almost for the last twenty-five.

Within this time our laboratories have multiplied almost by geometrical progression. In 1900 there was scarcely an industrial research chemical laboratory in America worthy of the name, although important beginnings had been made. Today the National Research Council lists one thousand. Little more than fifty years ago the chemical laboratory was beginning to find place in our universities, their first idea being simply to teach. Even with our universities the idea of laboratories for research began almost with the century. Today no university can secure students or carry public respect without modern laboratories, adequate equipment, and highly trained instructors, as well as investigators infused with the spirit of research. Within recent years Cornell, Yale, Harvard, Illinois, North

[1] Address delivered on the occasion of the dedication of the Charles James Hall of Chemistry at the University of New Hampshire, Nov. 9, 1929. See THIS JOURNAL, **7**, 812 (Apr., 1930).

[2] Published here by permission of *The Nucleus*. See *Nucleus*, **7**, 99, 103-6 (Feb., 1930).

Carolina, Michigan, Technology, Purdue, Iowa, Florida, Johns Hopkins, California, Chicago, Columbia, Minnesota, New York University, and others, have scrapped their old laboratories and built new ones, most of them costing from one to two millions of dollars. Other universities are seeking endowments. Many of us here today are but just returned from the dedication of the unsurpassed new chemical laboratory at Princeton, erected through the expenditure of $1,500,000 taken from invested funds by far-sighted trustees of that great institution when other means were lacking. Every chemist present thrilled at their appreciation of the investment value of the chemical laboratory to their university's future. Every chemist present glowed with pride in his profession when the oldest of the faculty and alumni, trained for the most part in the classics, art and literature, rather than the sciences, responded heartily to the plea for the new culture made to the parents and guardians of the undergraduates:

> To give serious consideration to the rich opportunities for scientific training now offered in contrast with earlier decades, and counsel and encourage their sons seriously to consider the opportunities to which they are heir. In return for their labors we offer them a life in science rich in its satisfaction, full, scholarly, and enduring.

No truer advice can be given to the parents, guardians, and students assembled here today.

The laboratory is, and more and more will be, the key to human progress. The door opens slowly but new vistas constantly appear. Progress comes by cumulative effort rather than by isolated discovery. We are still far from the zenith of knowledge. Who, listening a fortnight ago to the words of the great man who leads our nation, whose life has been based on the slogan, "Facts first, then judgment," could fail to be convinced of the laboratory's place in our domestic economy? President Hoover said, honoring Edison:

> Discovery and invention do not spring full-grown from the brains of men. The labor of a host of men, great laboratories, long, patient, scientific experiment build up the structure of knowledge, not stone by stone, but particle by particle. This adding of fact to fact some day brings forth a revolutionary discovery, an illuminating hypothesis, a great generalization, or a practical invention.
>
> Research both in pure science and in its application to the arts is one of the most potent impulses to progress. For it is organized research that gives daily improvement in machines and processes, in methods of agriculture, in the protection of health, and in understanding. From these we gain constantly in better standards of living, in more stability of employment, lessened toil, lengthened human life and decreased suffering. In the end our leisure expands, our interest in life enlarges, our vision stretches. There is more joy in life.
>
> The nation today needs more support for research. It needs still more laboratories.

Twenty-five years ago the earning power of the laboratory was only beginning to be appreciated. Today the millions of dollars expended on our

endowed institutions and the added millions yearly invested by our successful corporations in brains and facilities for brain creation is adding so vastly to our knowledge that the great problem of chemists today is to secure funds to record in print the output of new knowledge. Unless ample endowment for the recording of research is forthcoming, our children will labor again in fields already tilled.

In no country was the value of fundamental and applied research more early or more highly appreciated than in Germany. In no country were the financiers more quick to utilize chemical brain power and apply the discoveries made. In no country was greater financial support given by the government and by the people. Even German laborers lifted their hats when they passed the doors of the research laboratories that were rapidly increasing German wealth. They came near giving Germany control of the world. In her great laboratories, hundreds of fresh minds were yearly developed in chemistry and students of other lands were welcomed, inspired, and trained. Through her chemical advancement and supremacy alone she was able to feed her people, manufacture her munitions, and sustain the World War. When the War was over it was again to the chemical laboratory that Germany looked to reëstablish herself in the world's economy. By the pursuit of such a policy she has already made the most rapid recovery from disaster in world trade which history records.

America was already becoming strong-minded chemically before the war began. Her chemists proved in the war their training and worth by their accomplishments. Already our great universities were offering superior facilities in teachers, laboratories, and the tools of the profession although most of those facilities were manufactured abroad. Few students were going to Europe for study and they chiefly for the halo it still gave. In the war American chemists played a part not yet realized. They made munitions possible. They planned and built great chemical plants not only for high explosives and poison gases but for many materials that went into every essential from brass cartridges to airplanes and battleships. No chemist stayed in the ranks without concealing his knowledge and training. Early segregated as a profession by government order, some twenty thousand were held to service through chemistry, over four thousand wearing uniform in this capacity. Through their efforts and guidance America, at the armistice, was ready to supply munitions not only for itself but its allies. In mustard gas alone our resources were so great that the menace, known to the enemy, is reputed to have hastened, if not determined, the end. All of its success and preparedness emanated from the laboratory.

The war, more than anything else, made America a chemical nation, excelled by none today. Chemists had forgotten their inferiority complex. They realized and learned to admit what the profession had done and could

do. They planned and labored in one great unselfish organization, now numbering 17,500, which has no object but the advancement of chemistry and no counterpart in the world. Emoluments increased and laboratories multiplied. Only government plants were scrapped. Others were converted. Smokeless powder was turned into automobile finish, applied in one day instead of thirty. War equipment manufactures dyes and coal-tar pharmaceuticals. Economically, chemists, and their allied scientific associates, have made America, save for labor cost, independent of the world. To preserve that independence, through wise legislation, the American laborer owns his own home, drives his own automobile, and enjoys as the every-day necessities of life the luxuries of his less fortunate brothers of other lands. In truth, the words of Sir Wm. Ramsay, "The country which is in advance in chemistry will also be first in wealth and prosperity," find their exemplification here.

The laboratory is not cheap to build, to equip, or to maintain, but no investment pays more. The university laboratories have been responsible for many, if not most, of the discoveries that have made modern life possible. In them chiefly is done the fundamental research of the world; research that has only for its object the increase of knowledge without thought of other gain. But the laboratories of the General Electric Company have demonstrated to industry also that studies in pure science by Langmuir, Coolidge, and their colleagues pay great dividends where not even their mirage was contemplated. So fully is this now appreciated that the great laboratories of the du Ponts, of the Bell Telephone Company, of the Western Electric Company, of the General Electric Company, of the Eastman Kodak Company, of the Bakelite Corporation, of the Union Carbide and Carbon Corporation, of the American Cyanimide Company, and many smaller but equally enlightened corporations, do not hesitate to let their workers seek new knowledge, although no immediate application is in mind. Indeed, one of these corporations has appropriated one million dollars a year for pure research into the unknown, not from philanthropy but because they realize, sooner or later, they will find treasure there a hundred-fold.

Now and then, but not often, the dollar measure can be applied to the output of our laboratories. Over two billion dollars a year are estimated to be added to the world's wealth by the Bessemer process for the production of steel. Another two billions a year are saved in our lighting bill by the nitrogen filled electric lamp with ductile tungsten filament. The gasoline we use annually to the extent of eighteen billion gallons would cost us at least four billion dollars more had it not been for the laboratory which has doubled output and halved the cost of production. One improvement alone has saved the patentee $300,000,000 in his own practice and brought in $30,000,000 in royalties as well.

The discovery of mauve by Sir Wm. H. Perkin was the cornerstone of the industry derived from coal tar, employing thousands of men and more than a billion of capital, filling our homes with color and our lives with health and beauty.

The fixation of the nitrogen of the air first in the laboratory and then in the plant has added immeasurable wealth to the world and has saved the race from otherwise certain starvation. It is practiced today in all civilized nations. America has plants surpassed by none in efficiency and is at last quite independent of Chile and, indeed, of all the world for her fertilizer in time of peace and her defense in war. Over 300 tons per day of nitrogen is now being brought into combination from the air in the United States. Our country can now write off the cost of Muscle Shoals without regret, for its very idleness has encouraged industry to instal plants and methods that produce ammonia so cheaply that it is sold today at less than half the prewar price. It is one of the few commodities that has so declined.

Made practically useful by an accidental discovery on a kitchen stove, few commodities have profited more by the laboratory method than has rubber. This material which so wonderfully modifies the shocks of life employs today in our own country $665,000,000 of capital. The single laboratory discovery of the application of certain substances, known as accelerators, which hasten its vulcanization is estimated to save to the users of rubber tires at least $50,000,000 a year and as investment in plant to the rubber industry of an additional $40,000,000.

The demonstration of the germ theory and the development of serum by Pasteur is the greatest of all the accomplishments of the laboratory in history and alone in dollar value to mankind justifies a thousand-fold every expenditure made on laboratories in all the years of their service to mankind.

Endless examples of the laboratory's accomplishments might be cited. The amplification tubes which make distant and mass communication possible; the liquefaction of air; the accumulation of helium, the rare gases of the atmosphere and the new display lighting they make possible; the X-ray; the radio; radium; the production of sugar, of acetone, of methanol, of lacquer solvents, of paper, and of starch from corn; the conversion of trees into hundreds of products from smokeless powder to silk stockings; conversely, the conversion of sugar cane, of sawdust and of straw into boards; the hydrogenation of liquid oils to solid fats; of new alloys without number having almost any property in demand; of new light metals for cylinders and airplanes; of new plastics; new varnishes and lacquers; the preservation of food; and innumerable other modern necessities are the children of the laboratory. In short, the laboratory has been the key to the annihilation of space and time, man's great obstacles. We talk to

the polar regions, we fly across the oceans, we see through wires, we have harnessed energy to our bidding. All this and more has been conceived in laboratories.

The trustees of New Hampshire University were wise when they determined to erect and equip the splendid laboratory we are here to dedicate today. It is worthy of the great teacher and investigator in the realm of chemistry whose name it will henceforth bear. The investment they made thirty-five years ago in the Conant Laboratory has paid them well. I can scarcely understand today the pride I felt in the structure then erected. It was my first real charge. Forty thousand dollars was allowed me as a maximum for building and equipment. Less than a half dozen future chemists were there then in embryo. One of them alone has justified the full expenditure. From Conant Hall many of New Hampshire's sons have gone into the world to real accomplishment in the development that has come through chemistry. Few have stayed within the state, for New Hampshire is not yet chemical-minded. State lines today are little more than areas for taxation and the election of senators. So long as New Hampshire's sons succeed and leave the world improved by their sojourn the parents of New Hampshire are content. A rolling stone may gather no moss, but today a stone that fails to roll seldom finds a bed of moss in which to lie. Consider those you know and reflect. How many who have stayed at home and failed to make country, or even world-wide, contacts can claim even their rightful share of success? Conant Hall can claim only a small fraction of New Hampshire graduates, but their quality has been unexcelled. Research workers of note in some of the country's great laboratories, directors of more than one of those laboratories, the president of a great automobile company, the president of an important chemical corporation, a president of the American Institute of Baking now in charge of President Hoover's great child welfare work, chemical investigators in the Bureau of Dairying, the Bureau of Soils, the Bureau of Standards, and in the agricultural experiment stations. New Hampshire parents are justly proud of them. They are all loyal sons. Almost all look forward to their return to the "granite hills" bearing their moss with them.

Charles James Hall will prove the best investment ever made in New Hampshire if the trustees continue their support in the realization that laboratories are of necessity more expensive than classrooms but return a hundred-fold. New Hampshire parents, too, must realize the wonderful opportunities now offered here to their worthy sons. Chemistry is no profession for the dullard, but if their sons have brains, industry, and vision, and wisely carry through to their doctorate, they can count on an immediate annual return of thirty to fifty per cent on their investment. Furthermore, the yield will further increase faster than in the most productive of common stocks.

To Charles James—chemist of well-earned international reputation, inspiring teacher, cultured gentleman, and loyal friend—we dedicate this building. May his successors emulate his example and equal his success. May they obtain complete fulfilment of life in the consciousness of accomplishment.

METHYL OXALATE AND SUPERSATURATION

EVERETT BOWDEN, 955 WESTMORELAND AVENUE, WAUKEGAN, ILLINOIS

A solution of methyl oxalate in methanol is suggested as a combination with which to teach supersaturation, for the behavior of such a solution is very susceptible of control by varying the ratio of solute to solvent, and the temperature at which one chooses to start crystallization. Many students think of solution only in terms of water, and the use of methanol here is an advantage in correcting this idea. The use of a thermometer in the solution before crystallization is induced by seeding or agitation will give a qualitative idea of what is meant by latent heat of solution. A solution made by warming methyl oxalate with methanol in the ratio of fifty grams of the former to 100 ml. of the latter is convenient. Of course methyl oxalate is relatively expensive, but not in terms of student results.

The phenomenon of supersaturation is a hard concept for many students to grasp, partly due to the inherent difficulty of the idea, and partly due to the fact that the student does not always have an opportunity to demonstrate the phenomenon to himself in the laboratory, and when he does, he finds that the suggested materials do not work out well in the hands of inexperienced operators. Both of these latter difficulties may be remedied by allowing each student to work with a solution of methyl oxalate, which always "works," and this combination, in conjunction with a thermometer as suggested, should readily give the student the idea that a supersaturated solution is really an unstable solution, and therefore not at all at variance with the definition of a saturated solution which specifies a state of equilibrium with undissolved material.

Methyl oxalate is also a very convenient substance with which to demonstrate sublimation, supercooling, and metastability.

Abietic Acid Crystals Described. A four-color photomicrograph of abietic acid crystals grown in rosin is a feature of a 51-page booklet just issued by the Hercules Powder Company, Wilmington, Delaware.

According to this well-illustrated booklet abietic acid is a cheap organic acid. It is one of a number of terpene chemicals and organic compounds discussed.

The booklet may be had without cost by writing to the company.—*The Catalyst*

VISUAL AIDS IN CHEMICAL EDUCATION*

Visual aids in education have gained a resultant of forces of many added and powerful components during the past decade. In most respects, however, the principles involved by these aids are as old as man's first rude sketch. For the sake of clarity and agreement in the terminology of the field, it may be said that a visual aid includes "The representation of an object, a situation, or relationship in either two-dimensional line or three-dimensional form, which, when it accompanies language, tends to make the latter more interesting, intelligible, and impressive."[1] Thus it may be understood that the stock shelf in the chemistry laboratory becomes a more efficient visual aid when the cardboard cartons are replaced by glass bottles in so far as practical. The shelf is more efficient in the latter case, because the glass bottles make it possible for the students to see and to associate the appearances of chemicals more readily. The difference between powdered and flaked graphite, then, is not likely to be overlooked. The shelf can and should do something more than to serve as a depository for items necessary to develop some other visual aid in connection with the performance of an experiment.

In the same sense, the blackboard, chart, excursion, exhibit, globe, map, model, picture, and actual specimen of whatever kind, are to be thought of as visual aids. In no phase of the Committee's work is it the intention to minimize values inherently the property of the more common types of visual aids. With reference to the more common types, for example, it is a singular thing that the average required elementary courses and texts in educational theory and practice give little consideration to the problem of obtaining maximum value from textbook illustrations and the usual types of pictures available from other sources. At the same time, pictures traditionally have held an accepted place in the average textbook. What actually constitutes a picture of educational value?[2] This is a question which the average teacher is little likely to be prepared to answer completely. The same is true for the question, How is it possible to obtain the maximum value from the use of pictures?

Because films, film-slides,[3] stereopticon slides and stereoscopic pictures as visual aids have been less widely used and are less understood than the more common types listed above, and because the number of problems associated with these less widely used forms offer somewhat formidable

* The first of a series of articles from the Committee of the Division of Chemical Education of the A. C. S. on Aids to Visual Instruction in Chemistry.

[1] Weber, Joseph J., "Is the Term 'Visual Education' Scientific?" *The Phi Delta Kappan*, **11**, 78–9, 83 (Oct., 1928). Doris, Anna V., "Visual Instruction in Public Schools," Ginn and Co., **1928**, pp. 6, 15.

[2] Hollis, A. P., "Motion Pictures for Instruction," Chapter VIII; "A Score Card for Judging Values of Informational Pictures," Century Co., **1926**.

[3] Also called "still film" or "film strip."

appearance, the latter group is to be given a more extended consideration here.

A problem, for example, in the realm of newer types of visual aids is found in the fact that each of the films used in the Eastman Research Project was prepared under the same direction and with the same extreme care from scenario development to photography and psychological adjustment.[4] Why was it then that the total correct results for the film on the water supply for New York City were not closely comparable to the results for the related film on the purification of water for Chicago?[5] The highly developed research departments of leading advertising companies are mute evidence as to the importance of pictures, among other things, in the matter of developing to the highest state such psychological functions as attention, perception, conception, discrimination, and memory. Notwithstanding the fact that these problems are being, or can be solved,[6] the technical aspects and magnitude of the field as a whole are such that even the secondary school of average size could use to advantage a supervisor with training in the subject of visual aids.[7] Likewise, educational courses and departments for teacher training no longer can be thought of as rendering adequate service unless visual aids are taken into consideration.[8]

A very casual glimpse at the general developments centering around visual aids in the past few years is indicative of the consequence of the movement in the school of tomorrow. Approximately fifty cities in the United States are maintaining visual instruction departments.[9] In 1928, fifteen thousand educational institutions in the United States were using films for teaching purposes.[10] During the academic year of 1927–1928, the American Museum of Natural History in New York City distributed more than 3300 reels of films in 122 schools, reaching through this service

[4] Finnegan, T. E., "An Experiment in the Development of Classroom Films," *Transactions of Society of Motion Picture Engineers*, **112**, 545–63 (1927). "The Story of Eastman Classroom Films," 18 pp., gratis from Eastman Teaching Films, Inc., Rochester, New York, **1929**.

[5] Wood and Freeman, "Motion Pictures in the Classroom," Houghton, Mifflin and Co., **1929**; "Nation-Wide Experiment Grades Value of Films in Classroom Teaching," THIS JOURNAL, **6**, 153–7 (Jan., 1929); Wood, Ben D., "What Is the Potential Value of the Teaching Film?" *Nation's Schools*, **3**, 54–60 (Mar., 1929). Enlow, E. R., "Statistically Speaking—A Flagrant Misinterpretation," *Educ. Screen*, **8**, 228–9 (Oct., 1929).

[6] Griffith, Coleman R., Director of Laboratories of Research in Athletics, University of Illinois, Personal correspondence *re* utility in athletic instruction, Dec. 7, 1929.

[7] Astell, Louis A., "The Status and Trends of Visual Aids in Science," *Educ. Screen*, **7**, 183–4 (Oct., 1928).

[8] Hollis, A. P., *op. cit.*, p. 209.

[9] News and Notes, *Educ. Screen*, **8**, 75 (Mar., 1929).

[10] News and Notes, *Ibid.*, **7**, 261 (Dec., 1928).

more than 1,123,700 pupils; an increase of more than 100 per cent over that of the previous year.[10,11] The New York City schools, in the last academic year gave visual instruction to 2,380,381 children.[12] The Los Angeles school system, in the same year, had a motion picture circulation estimated at more than 20,000 reels with an increase in circulation of visual aids other than films of more than 100 per cent over that of the preceding year.[13] In Ohio, high schools to be given either an "A" or "B" rating must have "provisions for visual education, including educational motion pictures at least once a week; and other forms of visual instruction."[14]

Recent major research projects are substantiating the wisdom of all these investments. The pioneer of exact scientific methods applied to the field is Doctor Weber.[15] Following him are such leaders as Freeman,[16] Dudley,[17] Crandall, Finnegan;[4] and among the more recent is Lewin.[18] Of the institutional projects, Yale University has conducted a searching experiment for the worth of historical slides and films. The production of the "Yale Chronicles of American Photoplays" for fidelity and other values will stand as a monument to the school and department from which they issued.[19] The work of Harvard University in coöperation with Pathé, Inc., deserves more than passing note.[20] Along with all of these projects are to be numbered the experiments conducted by city systems such as that of New York.[21] From the industrial world has come the Eastman Research Project, referred to above. This project has been characterized as the most extensive educational experiment ever undertaken. For it, all methods and results were developed under direction of specialists

[11] "Added Distribution for the Bureau of Mines Subjects," *Educ. Screen*, **7**, 174 (June, 1928).

[12] News and Notes, *Ibid.*, **7**, 233 (Oct., 1929).

[13] McClusky, F. Dean, "Visual Education in the Los Angeles City Schools," *Ibid.*, **7**, 207 (Oct., 1928).

[14] "Ohio's Regulations Regarding Visual Instruction," *Ibid.*, **8**, 140 (May, 1929).

[15] Weber, Joseph J., "Comparative Effectiveness of Some Visual Aids in Seventh Grade Instruction," *Ibid.*, **1**, 131 (1922).

[16] Freeman, Frank N., "Visual Education," Univ. of Chicago Press, **1924**, 392 pp.

[17] Hollis, A. P., *op. cit.*, p. 220.

[18] Editor's Note and accompanying article; Lewin, William, "Teachers Hail the Talkies," *Educ. Screen*, **8**, 295–6, 305, 312 (Dec., 1929). Kitson, Harry D., "Teaching by Talkies," *Nation's Schools*, **4**, 45–8 (Oct., 1929).

[19] Knowlton, Daniel C., "Improving the Quality of Instruction in History with the Aid of the Photoplay," *Historical Outlook*, Part I, **20**, 167–79 (April, 1929); Part II, **20** (May, 1929). McClusky, F. Dean, "Experiments with Yale Historical Films," *Educ. Screen*, **7**, 244, 246 (Oct., 1929).

[20] McClusky, F. Dean, "Pathé-Harvard Films Released," *Ibid.*, **8**, 54 (Feb., 1929).

[21] "The Educational Value of Motion Pictures," *Am. Sch. Board J.*, **79**, 54 (July, (1929).

of the highest order in educational work.[3,4] "It is clear," as McClusky points out, "that visual materials have established their worth as educational factors in the school rooms of America."[22] And it is equally clear that with the worth established in America little remains for the establishment of values and practice in the countries beyond.

Obviously, with the increase in number of types of visual aids available, more judgment and information are needed to make efficient use of these aids.[23] Each type has its inherent virtues and faults. Problems in economics, in time, storage, flexibility in usage, and mechanical technic involved, are not all the issues to be met in no uncertain terms before every type of visual aid is fitted into the educational scheme. For example, the laboratory exists in no small measure because it is known to offer opportunities in the form of visual aids. Even the exact status of the laboratory in this educational scheme is not determined.[24]

In the development of a project on copper, one would not use a set of slides to show those steps involving inherent kinetic phenomena to elementary students[25] if excellent films, utilizing the animated diagram of such steps, were available. Nor would one be inclined, necessarily, to use either of these if the actual mining, milling, smelting, refining, or fabrication processes in question were easily accessible. Certainly one would not purchase a library of twelve reels on copper for use, except in colleges and the larger city systems, as long as it is possible to obtain the same material on loan from the government or other reliable source.[26]

The problem has other angles. All aids of whatever kind, to have a maximum value, need to be subjected to such considerations as the pedagogically fundamental idea of student participation in the social events and consciousness of the individual's surroundings, including the classroom.[27] To this must be added the sociological principle of imitation, as applied to the student and to the student's action, and also the psy-

[22] McClusky, F. Dean, Editorial, *Educ. Screen*, **8**, 54 (Feb., 1929).

[23] Weber, Joseph J., "A Suggested Methodology for the Use of Informational Motion Pictures," *Ibid.*, **7**, 8–10, 32 (Mar., 1928). Freeman, Frank N., "Some Principles on the Use of Visual Methods in Higher Education," *Ibid.*, **8**, 100–1 (Apr., 1929); **8**, 135–6 (May, 1929).

[24] Downing, Elliot R., "Teaching Science in the Schools," Univ. of Chicago Press, 1925, pp. 111–42. Croxton, W. C., "Shall Laboratory Work in the Public School Be Curtailed?" *Sch. Sci. Math.*, **29**, 79–83 (Jan., 1929). Downing, Elliot R., "A Criticism," *Ibid.*, **29**, 411–3 (Apr., 1929). Croxton, W. C., "A Reply," *Ibid.*, **29**, 730–3 (Oct., 1929).

[25] Hollis, A. P., *op. cit.*, pp. 82–4.

[26] Department of Commerce, Bureau of Mines, Pittsburgh Experiment Station, Pittsburgh, Pa. Film numbers 126–30, inclusive.

[27] Dewey, John, "My Pedagogic Creed," *J. Natl. Educ. Assoc.*, **18**, 291 (Dec., 1929).

chologically valuable experience of self-expression.[28] These aids need to be subjected to a classification on the basis of age and group levels. A film of maximum value to classes in college chemistry is not likely to be of maximum value to chemistry students in secondary schools. When chemistry comes to be taught in the elementary schools of this country as a general thing, still pictures are likely to be the media where the newer types of visual aids are used. Films, slides, and film-slides on chemical processes are now available in considerable quantities. Some of this material is satisfactory for classroom purposes and some of it is suited to auditorium work. More desirable materials in greater quantities would be made available if the various chemical industries were acquainted with the standards required by educators and had opportunities to cooperate with educational organizations in the matter of producing these aids. What more valuable contribution for the advancement of chemistry can be rendered, for example, than theses in the form of films or slide sets prepared by candidates for advanced degrees. In the preparation of this material is implied the selection of subjects essential to chemistry courses with emphasis on the subjects not conveniently or economically duplicated in the average laboratory. Further, it is implied that an adequate analysis of the educational worth of the individual films or slide sets be prepared, that the research findings for each project be set forth, that reference sheets be compiled, and that suitable lesson plans involving student participation and other principles be carefully developed for the group intended. In other words, the project should be developed to the point of being a practical working unit of established value for the course in which it is intended to be used. What such workers as Lewin have done in these respects others undoubtedly will take the opportunity to do, the general scope of the Eastman Teaching Films, Inc., and other similar organizations notwithstanding.

The element, illinium, will serve for a specific example illustrating more clearly the importance of visual aids in this connection. A film with incorporated lecture by Professor B. S. Hopkins, showing him and his assistants[29] using the original apparatus and demonstrating the principles involved, with some of the original product, would serve many educational purposes. Here would be the geographical scenes involving monazite and other

[28] Astell, Louis A., "How State Academies May Encourage Scientific Endeavor among High-School Students." Read before the Conference of State Academies of Science at Des Moines, Iowa, December 27, 1929.

[29] Harris, Hopkins, and Yntema, *J. Am. Chem. Soc.*, **48,** 1585 (1926); *Ibid.*, **48,** 1594 (1926); *Nature*, **117,** 792 (1926); *World's Work*, **53,** 700 (Oct., 1926); *Science*, **63,** 575 (1926); *News Ed., Ind., Eng. Chem.*, p. 5, March 20, **1926.** Quill, Lawrence L., "Illinium—Element Number 61," THIS JOURNAL, **5,** 561–8 (May, 1928). Ball and Harris, "Extraction of Commercial Rare Earth Residue with a View to the Concentration of Illinium," *J. Am. Chem. Soc.*, **51,** 2107–12 (July, 1929).

contributing sources of the element. Here would be the development of the scientific method and spirit,[30] both of which are more important than the facts, since the method and spirit may be the means whereby other discoveries are made. This living historical document, when available for college chemistry classes making a study of the rare earths, will serve as a compelling inspiration for scientific achievement. To such a record the lecturer in charge may make his personal contributions. Such things are being done in the general field of science.[31]

Add to this vision the forecast of the future motion picture as it is being developed. With lenses and films of vastly increased speed, with three-dimensional screening, and with natural full color,[32] we are to have an instrument for the advancement of all education as well as of all science; an instrument which extends materially our present general conception of possibilities.

This article has dealt more fully with the motion picture film than with other phases of visual education materials. In the subsequent articles issuing under the name of this Committee, it is intended to lay a foundation for constructive work in all phases of visual aids as applied to chemistry whether for juvenile or adult attention, whether for assembly or classroom. Through the careful study of materials at hand, the American Chemical Society has accepted the opportunity of maintaining chemistry as not only the best organized, but the best supplemented subject of science.

[30] Wiggam, A. E., "The Religion of the Scientist," *World's Work*, **50**, 397 (Aug., 1925).

[31] "Chemistry to Be Taught by Motion Pictures," *The Motion Picture*, **5**, No. 6, 7. Published by Motion Picture Producers and Distributors of America, Inc., 469 Fifth Ave., N. Y. C. "Development of Medical Films Praised," *Ibid.*, **4**, No. 12, 5 (Dec., 1928).

[32] Editorial, *Ibid.*, **5**, No. 6, 8 (1929).

Studies Effect of Air on Metals. Lead, tin, and stainless steel offer the most resistance to corrosion when exposed for years to the air, Dr. J. Newton Friend, head of the chemistry department at the Birmingham Technical College, in England, has found in a series of researches upon which he reported at the recent meeting of the Institute of Metals held at Düsseldorf, Germany. A number of cylindrical bars of different metals, each two feet long and an inch in diameter, were exposed on a Birmingham roof for seven years. Various kinds of brass were most corroded, though they passed the test much better than specimens of wrought iron and carbon steels. Aluminum resisted corrosion nearly as well as the lead and tin, though near a body of salt water this would not have been the case.—*Science Service*

STIMULATING INTEREST IN HIGH-SCHOOL CHEMISTRY*

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I shall endeavor to make a long story short by describing from among the various devices used in my classes to stimulate interest the one which includes them all. The activity referred to is the exhibit and open house that has become an annual affair in our chemistry department. Early in May each year we put on a program to which we invite the members of the Parent-Teacher Association, and particularly the parents of the students who are enrolled in chemistry. On that day and during the remainder of the week, we have on display the posters and exhibits which have been gotten up during the year. The making of these posters and exhibits never fails to arouse the keenest interest and some very excellent posters have been made on such subjects as glass, rayon, rubber, soap, ink, cotton, etc.

The posters are often a source of a good deal of merriment. One pupil said on hers that in water hydrogen and oxygen form a compact. Another declared that iodine has a violent vapor. A student who was making a poster on the life and work of Priestley became so engrossed with the subject of oxygen that when she was asked in geometry class to give the names of various polygons, she said, "A polygon of five sides is a pentagon, six sides, a hexagon, eight sides, an oxygen." Another was in the economics class. The letters H.C.L. occurred in the headlines of an article in *World News*. When asked the meaning of these letters, she immediately replied, "hydrochloric acid."

The best notebooks, and some are quite attractive, are placed where the visitors may examine them. The class Scrap Book is another source of interest. It contains clippings, pictures, and diagrams, with each page bearing the name of the student making the contribution. Visitors who are subject to the cross-word puzzle mania are surprised to see puzzles neatly worked out, but are puzzled by the unfamiliar terminology and secretly resolve to look into the subject of chemistry. Students who have submitted worthwhile essays in the National Prize Essay Contest have copies out for inspection.

When the audience has assembled, the program is opened with a poem such as "The Chemist" by Edgar Guest, "Ode to a Chemist," or something similar. Short papers on such subjects as "Why Study Chemistry?" are really instructive to the mothers who, in their school days, did not study chemistry and are interested in learning something about this fascinating science.

A student with superior technic is chosen to give a lecture-table demonstration. Last year a student gave a little demonstration entitled, "Some Interesting Color Changes," which included the preparation of Prussian blue, the precipitation of chrome yellow, the effect of a base on phenol-

* Presented before the meeting of the Arkansas Education Association at Little Rock, November 14, 1929.

phthalein, etc. In the course of her talk she mentioned the interesting color change produced by having nitric acid accidentally spilled on her hair—which is red.

The posters are brought before the audience one by one, and the particular subject of each is explained by the student who made it. An account of an inspection trip that has been made during the year is given by one of the students. The visit to the local water purification plant is always of general interest, but others are sometimes used. Other activities can be worked in, as the illustration of a paper by means of Keystone slides, the dramatization of an original play on chemistry, etc.

The feature that arouses most general interest is the chemical spelling match. This is worked out in various ways. Last year we called it "Chemical Baseball." We held a preliminary match and the two winning students were entitled to select their respective teams. Eight innings were played beforehand at intervals of several days. The score up to that time was posted on the blackboard and much interest was manifested as to which team would be victorious. It was a source of wonderment to the parents to hear their daughters declare that washing soda is $Na_2CO_3 \cdot 10H_2O$, borax, $Na_2B_4O_7 \cdot 10H_2O$, and alum, $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$. As many as possible of the compounds named were those with which the audience was familiar. It was a hard fought contest and the victors were quite elated with their success.

The last feature was "Chemical Fortune Telling." The visitors were allowed to draw apparently blank slips of paper. On these slips we had written amusing fortunes with cobaltous chloride, or "sympathetic ink." When these were heated over Bunsen burners, writing appeared as if by magic and delighted the owners with interesting prophecies.

All in all, the exhibit and program are most effective in stimulating interest. Students who have not studied chemistry visit the laboratory and are quite impressed by the activities of the class. Teachers from other departments also enjoy looking over the work that is on display. The program is not burdensome to the teacher since only one or two items require extra preparation—the major portion consists simply of projects that have been worked out during the year. It is quite refreshing to see the enthusiasm of the youngsters, working with so much earnestness and taking such keen delight in the accomplishing of something worthwhile.

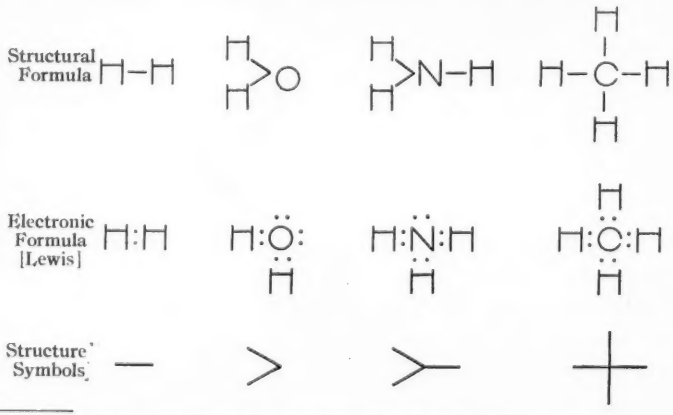
Watermelon Seed Makes Useful Drug. An extract made from watermelon seeds and given the technical name of cucurbocitrin has proved its usefulness in relieving many cases of high blood pressure, Drs. T. L. Althausen and William J. Kerr of the University of California Medical School have reported. These scientists stated that their work confirmed the results obtained with the watermelon seed extract by its discoverer, Dr. I. S. Barksdale, of Greenville, South Carolina.—*Science Service*

STRUCTURE SYMBOLS AS AN AID IN TEACHING

INGO W. D. HACKH, COLLEGE OF PHYSICIANS AND SURGEONS, SAN FRANCISCO, CALIFORNIA

Structure symbols[1] are an excellent means of conveying some of the principles of organic chemistry. They are a valuable tool in visualizing isomerism, asymmetric atoms, electronic shifts, and the intricacies of terminology. My teaching experience has fully convinced me of the decided advantages of this notation and the facility with which the beginner can make use of it. The advantages of the structure symbols[2] are summarized: *exactness* (for each symbol represents only one definite compound), *simplicity* (for with few rules the thousand of symbols can be constructed and their meaning understood), *accuracy* (for it is impossible to write a symbol for a given formula which is not theoretically correct, provided the rules are adhered to), *compactness* (for the symbol takes often less space than the name of the compound), and *clearness* (for the designs of the symbols are distinct, are grasped in a single glance).

The structure symbols themselves involve no new theory, they are merely the valence skeletons obtained when the well-known structural formulas are written *minus* the symbols for C, H, O, and N. They adapt themselves with equal facility to the language of "bonds" or "nonpolar electron pairs," and the key to the entire system is the assumption that: hydrogen has a valency of *one* or shares *one* pair of electrons, oxygen has a valency of *two* or shares *two* pairs of electrons, trivalent nitrogen shares *three* pairs of electrons, carbon has a valency of *four* and shares *four* pairs of electrons. In the structure symbols a line indicates a valence



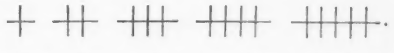
[1] *Science*, **48**, 333 (1918); *Chem. Age* (London), **3**, 392 (1920).

[2] The term "chemical shorthand" is not appropriate, for shorthand implies abbreviation, whereas structure symbols are more explicit than rational formulas and on the same level as structural formulas.

bond or a pair of electrons which is shared in common, and the four elements named are indicated, respectively, by points from which *one*, *two*, *three*, and *four* lines radiate. The points are determined by the termination of a line or the junction of lines as the comparison between structural formula, electronic formula, and structure symbol on page 836 shows.

All other elements, as well as tetravalent oxygen or bivalent carbon are indicated by their symbols in the proper place, thus >S for hydrogen sulfide, >P for phosphine, etc. Asymmetric atoms are indicated by a dot at the junction of a line. Ring compounds are drawn as geometrical figures, thus a pentacyclic compound as a pentagon, etc. The lines between atoms should be of equal length; straight lines for single bonds, curved lines for double bonds. These are all the rules necessary for the complete mastery of the system, and the writer has never encountered a student who did not understand this notation after the first lecture period. The following examples may illustrate the adaptability for classroom exercises.

The hydrocarbons are generally the first group of compounds which the beginner in organic chemistry encounters. The structure symbols for the first five normal hydrocarbons are,



METH-ANE ETH-ANE PRO-PANE BUTANE PENTANE

These signs represent, conventionally, the linkage of the carbon atom on a plane surface, but as molecules have three dimensions in space, this straight line is rather curved and resembles a screw. Structure symbols are therefore not intended to give an actual picture of the atomic positions within the molecule, but are rather a schematic diagram of the inter-atomic linkage. With this warning to the beginner we proceed to show the isomers; for instance for hexane:

1 2 3 4 5

STRUCTURE SYMBOLS FOR HEXANE AND ISOMERS

None of these compounds contains an asymmetric carbon atom, hence none of them is optically active. To test for an asymmetric atom we imagine that we are standing at the point where the atom is located and look now in succession to the north, east, south, and west: if we see in *each* direction a different arrangement of atoms, the carbon atom is asymmetric; if, however, in two or more directions there is the same atom or group of atoms no asymmetry exists. Applying this test to the above examples we find in No. 2 that the second carbon has two methyl groups; the third carbon of No. 3 has two groups; the second carbon of No. 4 has three methyl

groups, and in No. 5 the second and third carbon atoms have each two methyl groups; thus none of these compounds exhibits optical activity.

The same structure symbols shall now be used to illustrate and practice terminology. Accordingly we shall try to find as many names for the compounds represented by these symbols. We shift our compound of reference from hexane, to pentane, to butane, to propane, to ethane and finally to methane, and prepare a list something similar to the following:

1. Hexane, 1-methyl-pentane, 1,4-dimethyl-butane, 1-methyl-3-ethyl-propane.
2. 2-methyl-pentane, 1,1-dimethyl-butane, isopropyl-propane, 1-methyl-1-propyl-ethane, dimethyl-propyl-methane.
3. 3-methyl-pentane, 1,2-dimethyl-butane, 1-methyl-1-ethyl-propane, 1,1-diethyl-ethane, diethyl-methyl-methane.
4. 2,2-dimethyl-butane, 2-ethyl-2-methyl-propane, 1,1-dimethyl-1-ethyl-ethane, trimethyl-ethyl-methane.
5. 2,3-dimethyl-butane, 1,1,2-trimethyl-propane, 1,1,2,2-tetra-methyl-ethane, dimethyl-isopropyl-methane.

These names do not exhaust all the possible ones, but they are suggestive of the system of terminology. Reconstructing the structure symbol from these names is simple; thus 1,1,3-trimethyl-propane requires first the writing of the structure symbol for propane: and, second, adding the

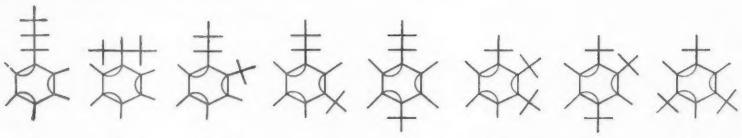
PROPANE

three methyl groups to the first and third carbon atom, respectively; thus:

1, 1, 3—TRIMETHYL PROPANE

Remembering that there may be free rotation of the single bond, all these symbols are identical with No. 2 above.

Similarly the aromatic hydrocarbons are readily visualized; for instance, the isomers of C_9H_{12} are:



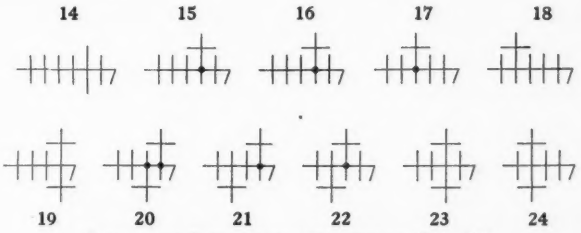
6 7 8 9 10 11 12 13

STRUCTURE SYMBOLS FOR C_9H_{12}

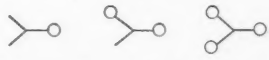
and the corresponding names:

6. Propyl-benzene.
7. Isopropyl-benzene, cumene.
8. 1-ethyl-2-methyl-benzene, 2-ethyl-toluene.
9. 1-ethyl-3-methyl-benzene, 3-ethyl-toluene.
10. 1-ethyl-4-methyl-benzene, 4-ethyl-toluene.
11. 1,2,3-trimethyl-benzene, hemimellitene.
12. 1,2,4-trimethyl-benzene, pseudocumene.
13. 1,3,5-trimethyl-benzene, mesitylene.

Substituting the hydroxyl group for a hydrogen atom, that is considering the alcohols or phenols derived from these hydrocarbons, greatly increases the number of possible isomers, as is shown by the following structure symbols for $C_6H_{13}OH$:

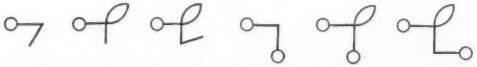


STRUCTURE SYMBOLS FOR ISOMERS OF $C_6H_{13}OH$

Of these compounds, 15, 16, 17, 21, and 22 contain each one asymmetric carbon atom, and 20 contains two asymmetric carbon atoms. Hence there are the corresponding dextro- and levo-forms which are conveniently and conventionally written by reversing the symbol. The primary alcohols are those containing the $—CH_2OH$ group; as, 14, 16, 17, 18, 22, 23, and 24. The secondary alcohols are 15, 20, and 21, while 19 is a tertiary alcohol. Using a circle for any hydrocarbon radical, there are the characteristic symbols for primary, secondary, and tertiary alcohol, and likewise  for primary, secondary, and tertiary amines. These general structure symbols are extremely useful in recognizing rapidly the type of a compound and establishing a mental picture of their relationship. Thus we have

PRIMARY SECONDARY TERTIARY
ALCOHOLS

PRIMARY SECONDARY TERTIARY
AMINES



R·OH R·CHO R·COOH R·O·R R·CO·R R·COO·R

ALCOHOLS ALDEHYDES ACIDS ETHERS KETONES ESTERS

With little practice these symbols will fix themselves upon the mind and enable a student to recognize them in the structure of a more complex compound. During ten years of experience there was found no structural formula which could not be represented by a structure symbol. They have been found to be useful in showing the relationship among the terpenes and alkaloids[3] as well as other large molecules; *e. g.*, dyes and peptides. A systematic list of some radicals and compounds has also been published[4] and shows the facility with which the principle of bold-faced type can be utilized by making the lines heavier.

So far the orthodox treatment of organic chemistry has been considered. The future sees the application of electronic concepts to the organic molecule. Various attempts have and are made to picture, to some extent, the distribution of the electrons which constitute a non-polar bond. Thus in different notations this non-polar bond is: A——B, A—o—B, or A—:—B for those cases where the electron pair is half-way between A and B, and A+——B, A——o—B, or A——:—B, for those cases where the electron pair is displaced more toward B, that is, where A has become positive and B negative in relation to one another. In the Lewis symbols, pictured at the beginning of this article, all of the valence electrons are shown, but no account is taken of the relative distance of the electrons in a non-polar bond. The "electronic" structure symbols enable a combination of the advantages of both types of notation, thus: dots upon a line are the valence electrons of the non-polar bonds, that is, the electron pair which is shared in common, each atom contributing one electron. Dots outside the lines are the valence electrons which are not shared but which complete the octet. The relative position of the dots on the lines is an indication of the "positiveness" or "negativeness" of the atom, the closer the more negative. The typical non-polar bond is in 25, where the electrons are assumed to be half-way between carbon-carbon and carbon-hydrogen. In 26 the carbon has become slightly positive with respect to nitrogen. In 27 still more positive and in 28 most positive. As a result the hydrogen atoms have become successively more negative, due to the nearness of the electron pairs.

[3] "Some Constituents of Essential Oils and Their Structural Relations," *J. Am. Pharm. Assoc.*, **9**, 948 (Oct., 1920). "Structural Relations among Opium, Berberis, Corydalis and Hydrastis Alkaloids," *Ibid.*, **10**, 680 (Sept., 1921).

[4] *Chem. News*, **136**, 17 (Jan. 13, 1928): also in *Química e Industria*, **6**, 22 (Feb., 1929).

In 28 are distinctly negative hydrogen atoms, which means the hydrogen atoms can be readily replaced by negative groups; as, halogens.

25 ETHANE | 26 METHYL AMINE | 27 METHANOL | 28 METHYL CHLORIDE

In the case of methanol, No. 27, it is noticed that there are two kinds of hydrogens, the methyl-hydrogen which is relatively negative; replaceable by negative atoms or groups, and the hydroxyl-hydrogen which is relatively positive; replaceable by positive atoms or groups. In a similar way the electron shifts of Lucas theory and the Pauling structure of benzene can be visualized.

So far the structure symbols have stood well the test of time and they promise some useful applications in the future. As a help to the beginner and as a tool to the student, they are recommended for extensive use.

Sex Hormone Isolated by German Chemist. The important sex hormone has just been obtained in pure form for the first time by a German scientist, Dr. M. Butenandt, working at the laboratory of a recent Nobel Prize winner, Professor Adolf Windaus, at the University of Göttingen.

This hormone, which has been known to the medical profession for some years, is thought to be capable of restoring the functioning of the reproductive organs. Heretofore it has been obtained only in combination with other compounds, but Dr. Butenandt has been able to produce the hormone itself in pure form, as a crystalline substance which he has named progynon.

The sexual hormone is one of a number of curious and as yet little understood substances which are secreted by the ductless glands of the human body. Each of these special chemicals is responsible for the proper functioning of certain bodily activities, and physiological chemists believe that a systematic study of these secretions will lead not only to an understanding of the physical operations of the body, but even to an explanation of mental characteristics and that elusive property called "character."

The importance of obtaining a hormone in a pure state is that it is the first step toward the determination of its structure and its synthetic production in the laboratory. The action of the hormones within the body and their influence on other chemical processes of the body may be better understood after the structure of the hormones has been determined.

Progynon belongs chemically to the group of stearates, or fats, and it is related to the artificial vitamin, vigantol, discovered by Professor Windaus. This also puts it in the same class as the poison of toads and the bile acids. On the other hand, adrenalin, the hormone of the suprarenal glands, is related chemically to the plant drugs known as the alkaloids, of which morphine is a well-known example. Adrenalin was the first hormone isolated in a pure state, and it has since been produced synthetically.—*Science Service*

AN EXPERIMENT IN SEGREGATION OF CHEMISTRY STUDENTS ACCORDING TO THEIR PROFESSIONAL INTERESTS*

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In the larger colleges and universities, students in general chemistry are sometimes sectionized on the basis of the curriculum from which they come. The most common groupings are home economics, engineering, premedical, agriculture, and chemistry. Usually little differentiation is made in the instruction given to these groups. Such specialization is frowned on by deans and by chemistry staffs for such reasons as the following: (1) Uniform preparation is not given for advanced courses. (2) The teaching schedule might be increased, which is undesirable from the standpoint of the department budget. (3) Division lines make for inflexibility. For example, irregular students in one curriculum cannot, without some inconvenience, take their chemistry with students from another curriculum, nor can a student so easily transfer from one curriculum to another. (4) Differences in the content of the courses call for extra equipment for the laboratories, storerooms, and lecture table. (5) But the principal objection is that administrative officers see no reason for such specialization. According to their thinking, all students need the same drill on the fundamentals of chemistry, leaving all the professional aspects of the science to subsequent advanced courses in the various professional schools.

At the University of Illinois, students from the College of Engineering are segregated during the second semester of the course in general chemistry. This sectionalization had its origin in the fact that the various engineering curricula allow one less hour for chemistry than the other curricula of the university. Hence the situation was one of necessity, rather than principle. Up to 1923, these engineering students were given practically the same instruction that was given to the other groups, without any attempt at differentiation in favor of their professional interests. The content of the course was the chemistry of the metallic elements, presented in the usual way, stressing the fundamental laws and generalizations of the science. It was no secret that these young engineers hated the course. Their conduct in the lecture room and laboratory showed that. The mortality in the course was high, failures running sometimes as high as 15 per cent. The situation was aggravated by certain members of the engineering faculty openly expressing the opinion that theoretical chemistry was of no value to engineers.

As an attempt to meet this situation, it was decided to try out, as an experiment, the presentation of the subject primarily from the industrial standpoint. Theories were to be introduced secondarily, at points where they served best to explain experimental facts. After trying out the plan for six years with classes of 300 to 400 students per year, we are now in a

*Read before the Division of Chemical Education at the Minneapolis Meeting of the American Chemical Society, September 9–12, 1929.

position to cast up averages and say whether the experiment has been a success or not. Average grades are tabulated in the following table:

Year	Enrolment	Av. grade
1918–19	244	76.3
1919–20	510	75.7
1920–21	398	76.5
1921–22	323	77.2
1922–23	303	76.3
	Change to new plan	
1923–24	314	74.6
1924–25	338	79.5
1925–26	342	78.6
1926–27	378	79.5
1927–28	388	80.2
1928–29	328	82.0

It will be noticed that there has been a steady increase in the average grade since the time of the change in 1923. These figures become more significant on comparing them with the records of other classes in general chemistry for the same period, in which we find a certain fluctuation, but no definite, steady improvement as shown here.

The subject matter of the course can be only briefly outlined. As stated before, the general content of the course is the metallic elements. The course is introduced by a lecture on the principles and practice of metallurgy. The general chemical and mechanical aspects are discussed in a non-technical way, representing the fundamental reactions by equations. As far as possible, a lecture is given to each of the important elements. Under each element, preparation processes are described for the derivatives that are industrially important, every care being taken that the process described is modern and in actual use at the present time. The properties of each product, particularly the ones involved in its industrial application, are developed so as to explain its uses. As opportunity permits, commercial and economic relations are traced, so as to show the important part that chemistry plays in modern industry. Steel and iron alloys, portland cement, boiler water, and fuels are given rather extended treatment. In addition to the topics generally treated in first-year textbooks a number of special topics are included, *viz.:* alloys and their properties, corrosion of iron products, industrial plastics, paints and varnishes, explosives and so forth.

The theoretical side, while ostensibly made secondary to the practical side, is by no means neglected. Reversible reactions come up in such processes as the reduction of ores, the setting of mortar, and the zeolite process for softening water. In just the same way, the Le Chatelier principle of energy effects on equilibria is brought out in actual processes. Electro-

chemical reactions are strongly emphasized in such topics as electrolysis, electroplating, and primary and storage cells.

Probably the most notable feature of the new course is the approach to the subject. At the very beginning, the students are told that the course is essentially a course in engineering, and as far as possible contact with that field is maintained to the end. No special omniscience is claimed by the teacher as to engineering practice, and he invites correction for any slip that he may make in an unfamiliar field. The result has been that the students are very alert and find great sport in taking their mentor to task for any of his lapses. There is seldom a lecture or a recitation in which one or more of the boys do not remain to talk over some process in which they are interested. And it must be admitted that many of the points brought up by them are worth consideration. I might illustrate some of their questions: Why does junk copper in brass founding cause rotten castings? Why does not the limestone slag out the silica lining in the blast furnace? What makes brick break during firing? Why is not all the sodium hydroxide of commerce made electrically?

Very naturally, the course has also increased in popularity with the instructors. There are several of us who really enjoy and ask for the privilege of teaching this course.

In conclusion, it must be admitted that this experiment is not a conclusive argument in favor of segregation. Its success may lie wholly in the fact that applied chemistry is more interesting than theoretical chemistry. It is just another case of definite results, but doubtful interpretation. All that can be done is to offer this report merely as a contribution to the great question, what should be the object and content of a one-year course in college chemistry? The experiment indicates that by taking advantage of the natural interests of the student, more chemistry can be taught. On the other hand, many teachers hold that it is better to give the student a more theoretical, if less interesting course, with the hope that he will in his own good time find a way to apply these principles to his professional work.

Research—First Floor. Research has come down from the attic, where a lonesome genius labored by himself; it is now a coöperative science, housed in well-equipped laboratories.

Earl P. Stevenson put it well, in speaking before the American Association for the Advancement of Science, when he said: "Organized research does not depend upon individual genius; it is a group activity, as distinct an activity as selling merchandise; it is as capable of organization and direction; so-called business methods are equally productive in its administrations."

In a word, research is now a first-floor science, a management function related to profit-making as definitely as are sales and advertising activities and budgeting.—*Business Chem.*

DIFFERENTIATED CHEMISTRY IN THE JUNIOR COLLEGE*

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There has been almost as much talk of late about the college chemistry course as there has been about one of the amendments to our United States Constitution and nearly as many solutions offered. THIS JOURNAL has aided tremendously in keeping before us the best there is in current thought and practice on the question. Most of the articles have originated from the smaller colleges. That is to say, the large state and endowed universities, with one exception, do not seem to be experiencing any difficulty with their freshman chemistry courses. I believe there is a good reason why they are not and perhaps the same reason accounts for our trouble.

The high schools have solved their problems by separating their fast and slow chemistry students into separate sections. X and Y courses in high-school chemistry have been established for half a dozen years or more in the leading high schools of our country. But at the junior college we hear about modified courses, about special courses, courses for students who have had no high-school chemistry and all the rest of the pandemic and panaceic courses in chemistry. There are also the "diploma" courses offered by some of our junior colleges and those of you familiar with this type of course know its value. To those not familiar with it I will say more presently. I want to speak for the moment to those who are offering no beginning course in chemistry except the regular freshman course of university standard. I want to tell you of our situation in Sacramento to see how it may compare with yours. There we have an excellent high school giving chemistry in two sections, the fast group and the slow group, or X and Y courses. These courses are entirely separate, full recognition being given to students of different ability. Then at the junior college we take in these students, both the X and Y students, and many more, many whom the university would never receive, that is, the Form B students. The X and Y students want chemistry, so do the Form B students in general, as well as the Form A. Shall we give them all the same course? Let us see.

We take much pride in our chemistry at Sacramento and try to give a course just as close to university caliber as is within our power. There is nothing unique in this; any junior college under rigorous state supervision must do the same, but we are doing this, not with university students, far from it. In fact, the *bulk* of our students could not matriculate at the University of California or Stanford. For every "university" student (Form A student) that we have in our classes, we have two non-recommended students sitting right beside him. That is the ratio, two to one. In other words, 66% or 669 out of 1005 of our regular students this year were Form B students. Now what kind of grades would these students have received in

* Address to the Division of Chemical Education, Berkeley meeting in the fall of 1929 of the American Association for the Advancement of Science.

freshman chemistry if by some means they could have been allowed to take university chemistry? A few I warrant would have passed, but certainly the majority would not. What then if we in junior college should give failing marks to this 66%, also failing marks to three or four per cent of the Form A's as is customary? It could not be done and this brings out more emphatically our purpose in the junior college.

We are decidedly not just a first two years of university. If we were, we would not have two-thirds of our student body made up of non-recommended students. The question may arise then, isn't the junior college tending to become more like the university as the college grows from year to year? Perhaps it should, but the facts at Sacramento show exactly the opposite, namely, that we are growing to be less of a university institution. Each year sees a higher per cent of non-recommended students constituting our classes. In 1925 but 45% of the enrolment were Form B students. By 1927 the honors were divided, a fifty-fifty proportion enrolling, and in October of last fall the Form B students enrolled in twice the numbers as did Form A students. I would not say this is an alarming situation, but it does indicate the nature of the work placed in the hands of the junior college, and if the kind of students we are teaching determines the nature of our school then we are primarily not a little university or a part of a university at all, but a terminal institution and we are becoming more of one every year. Why then should not more terminal courses be given? Fortunately, a few are being given and these colleges which we most recognize as leaders are offering courses for the Form B students. They are the "Diploma" courses which I have previously mentioned. These courses are open to and must be taken by the Form B student until he makes sufficiently high grades to warrant his transfer to courses giving university credit. This is a most commendable recognition of the two-fold duty incumbent upon the junior college and some scheme of this kind must be used to handle the situation. We have a more diversified problem than the university. We cannot mix our chemistry students all in one course. They were separated for us in high school and the difference between the two groups of students has been increased by the time they reach the junior college, increased by the difference between an intensive chemistry course to the one group and a weaker course to the other group.

Appreciating then the need for a differentiated course a word might be said about the nature of the course itself. There have been so many ways of giving modified courses that I shall not outline a new type. I know that each one of you has had experience of one kind or other in shaping a modified course. That alone is a considerable problem. There is one tendency in making a modified course which should be watched rather closely, I would say, and that is the tendency to favor a little too much the spectacular. In an effort to make the course appeal to the student,

there is apt to be an over-emphasis of the striking hair-raising demonstrations with perhaps too much slighting of the fundamentals. In any event, the differentiated course should not be adjusted to a level too far below the ability of the diploma student. It should tax his ability as much as the regular course taxes the brighter student's ability. I say this because an authority of the Sacramento High School has mentioned to me a tendency for some of the brighter students to take the weaker courses because they are easier and when allowed to choose for themselves, anything suffices just to "get by." The scope of the course I shall not attempt to discuss in detail. To quite an extent it may depend upon the needs of the particular class of students. The instructor's personal interests and background are always reflected. I would say it should differ from the regular course in point of emphasis and as to rate of ground covered rather than to subject matter. After all, the courses of freshman chemistry given by the universities are not so far wrong, but the difficulty which the poorer student encounters is the rapid rate at which the course develops. He needs more time to assimilate the fundamentals which the quicker student grasps more readily.

We tried an experimental course this spring semester at the Sacramento Junior College in addition to our regular freshman course. It was open to any and all students. Obviously it was a differentiated course, but to accommodate a few pre-professional and engineering students we still called it Chemistry 1A that they might secure their university credit. Then as insurance that the proper standard would be attained by these pre-medical and engineering students, it was stipulated that a grade of at least B must be obtained to permit further work in chemistry. In spite of these stipulations they flocked in to enroll. Nearly eighty started the course. That is one point where we resemble the university, they grasp for an easy course. I imagine it was not as easy as it might have been for some twelve or fourteen dropped it very quickly. Some of the results of the course were interesting. The student who received the highest number of points (the tests were all objective) had had no high-school or other previous chemistry. This was just an experimental course and more or less of an emergency measure. It served its purpose and was on the whole quite satisfactory.

There are other ways in which the less apt or less interested student has been provided for in chemistry. At the University of California at Los Angeles they are giving the customary chemistry 1A-1B of five units per semester and in addition they offer a chemistry 2A-2B of four units per semester for which there are no prerequisites. The course is accepted in satisfaction of science requirements for the junior certificate but gives to the student two units less than the regular year course. It moreover does not lead to higher chemistry courses.

I might mention that we have had a virtual differentiation for some years at the University of California at Davis. There they have the courses for

the regular students who are candidates for degrees and there are the courses for the non-degree students. The two are entirely different.

One hears some of adjusting the course to the pace of the best students and letting the balance get out of it an amount proportional to their interest or ability. By this means it is said differentiated courses are not necessary. I need say little more about this. The backward student in a laboratory course takes too much of the instructor's time. The better student is robbed. Either that, or the slow student becomes thoroughly discouraged and drops out.

I believe that a differentiated course of some sort, as well as the regular course, has become a necessity in the junior college.

EPITAPHIUM CHEMICUM, 1791

Here lieth to digest, macerate, and amalgamate with clay,
In balnec arenae,
Stratum super stratum,
The residuum, terra damnata, and caput mortuum
OF A CHEMIST.
A man who in his earthly laboratory
Pursued various processes to obtain
THE ARCANUM VITAE,
Or the secret to LIVE;
Also the AURUM VITAE, or
The art of getting, not making, gold.
Alchemist-like, he saw all his labor and projection,
As mercury in the fire, evaporated in fume,
When he dissolved to his first principles,
He departed as poor
As the last drops of an alembic.
Though fond of novelty, he carefully avoided
The fermentation, effervescence, and
Decrepitation of this life.
Full seventy years
His exalted essence
Was hermetically sealed in its terrene matrass;
But the radical moisture being exhausted,
The Elixir Vitae spent,
And exsiccated to a cuticle,
He could not suspend longer in his vehicle:
But precipitated gradatim,
Per campanem,
To his original dust;
May the light above,
More resplendent than Bolognian phosphorus,
Preserve him
From the athaner, empyreuma, and
Reverberatory furnace of the other world:
Depurate him from the faeces and scoria of this;
Highly rectify and volatilize
His ethereal spirit;
Bring it safely out of the crucible of earthly trial,
Place it in a proper recipient
Among the elect of the Flowers of Benjamin;
Never to be saturated till the general resuscitation,
Deflagration, calcination,
And sublimation of all things.

The Kalends of The Williams & Wilkins Co.

The Russian Sulfuric Acid Industry is to be extended greatly. The utilization of waste gases from smelting works is to be systematically developed. The smelting works already operating can supply sulfur dioxide for the production of 800,000 tons of acid.—*Chem. Age*

A SURVEY OF CHEMISTRY AS TAUGHT TO AGRICULTURAL STUDENTS*

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Chemistry has long been considered one of the basic subjects which agricultural students must master. At the present time, however, there is considerable agitation from certain agricultural branches regarding the advisability of requiring as much chemistry as has been previously thought necessary. This has taken several forms. Most prominent, perhaps, of these is the request for special freshmen courses in chemistry shortened and made pandemic presumably to fit the agricultural student. Then there is the question brought up by certain departments that they desire to teach the practical applications of chemistry themselves and consequently desire only the so-called pure or basic chemistry to be taught by the chemist.

With these thoughts in mind a questionnaire was planned for teachers of chemistry in the United States and Canada, seeking to ascertain how much and what types of chemistry were being taught agricultural students. It also seemed desirable to record the attitude of these teachers on a few other subjects pertinent to the teaching of chemistry to agriculturists.

This questionnaire was sent to some teacher in each of our major agricultural colleges. Forty-two in this country and Canada responded. In order to make the answers to the first three questions of real value, however, it was felt that figures should be secured from all schools. Such figures have been secured by carefully studying the college catalogs for the institutions not represented by returned questionnaires and it is believed that they are satisfactorily accurate.

As is inevitable there has been considerable ambiguity in answering certain questions and whenever possible these answers have been checked, using the appropriate college catalog.

The questions[1] will be taken up one at a time and results given as they appear from a study of the summary of answers.

Questions

1. *Semester or Quarter Terms*
   Two-Year or Four-Year Course in Agriculture

There were 58 schools checked to ascertain their term length and 39 were found to be using the semester or half-year system and 19 the quarter or one-fourth year term. These answers are necessary to evaluate the results in question two.

* Presented before the symposium on "Teaching Chemistry" at the joint session of the American Association for the Advancement of Science with the Midwest Regional Group of the A. C. S., Des Moines, Iowa, December 27, 1929.

[1] The answers to certain questions which have no bearing on the subject matter here covered, are omitted.

Out of 41 schools answering the second part, only one was on a two-year basis and four used both, so that for our study the four-year course will be used as a basis.

2. *Number of Hours of Freshman Chemistry Required*
   Additional Freshman Chemistry Elective
   Any Qualitative Analysis
   Special Course for Agricultural Students

The answers to this question were naturally given in either semester or quarter hours (Canada excepted) and since the majority of schools use the semester term, the quarter hours were evaluated in terms of semester hours.

The 58 schools for which figures were secured require a wide range of semester hours as shown below:

Semester hours	5, 6, $6^2/_3$, $7^2/_3$, 8, 10	
Number of schools	2, 6, 5, 5, 29,16	Average 7.84

Only three of the questionnaires indicated any freshman elective work, in addition to the required work as shown above, and these were schools using the quarter term.

Forty-five schools were checked regarding qualitative analysis for freshmen and 28 or 66 per cent indicated in the affirmative. From a perusal of the catalogs this would seem to be a minimum figure.

Only five of the schools were shown as giving special courses for freshmen. A few others stated they had separate sections but used the same material for all.

3. *Total Hours Beyond Freshman Chemistry Required* (*Sophomore, Junior, or Senior years*).
   Organic
   Organic and Physiological
   Quantitative
   Combined with Soils

In answering this question it was found that several schools did not require chemistry until the sophomore year or later so that the question could better be stated as "Total hours beyond first-year chemistry." The answers to this question cover a wide range of values as shown below:

Semester hours	0	2	3	4	5	6	7	8	9	10	12	
Schools	4	3	7	8	6	15	2	5	2	3	4	Average 5.5

It is at once apparent that the majority of schools require between 3 and 6 hours of advanced chemistry. The distribution of these hours is also exceedingly interesting. Thirty-one out of the 56 schools checked required some organic chemistry, 12 required some organic and physiological, while

21 required some quantitative analysis, usually in addition to the organic work, although not necessarily. From these figures it is apparent that not very many of the schools are teaching applied organic or physiological chemistry to their students. For a more detailed and localized account of this work reference is made to Map 1.

5. *Texts Used—Lecture*
   1. Course No. *3. Course No.*
   2. Course No. *4. Course No.*
   Laboratory (*If your own, so state*)

From a study of the answers to this question we find that only 11 schools report the use of texts such as Phillips' or Chamberlain's written primarily for agricultural students and which include considerable, in addition to regular, organic chemistry. This figure is probably a minimum due to a failure of some to answer this question. Many report the use of such texts as Rice's or Lowy and Harrow, organic texts with a biological tendency. Of particular interest, too, in showing the diversity of advanced work given is the fact that 18 report using their own laboratory manuals, and several more use a combination of their own with printed ones.

8. *Is There a Separate Soils Course?*

This question is of particular interest since in many schools this course contains considerable chemistry, so that the figures for total chemistry as shown on the map could well be increased in many cases by the hours of soils work. In fact most of the articles cited at the close of this paper refer to soils chemistry as the original agricultural chemistry.

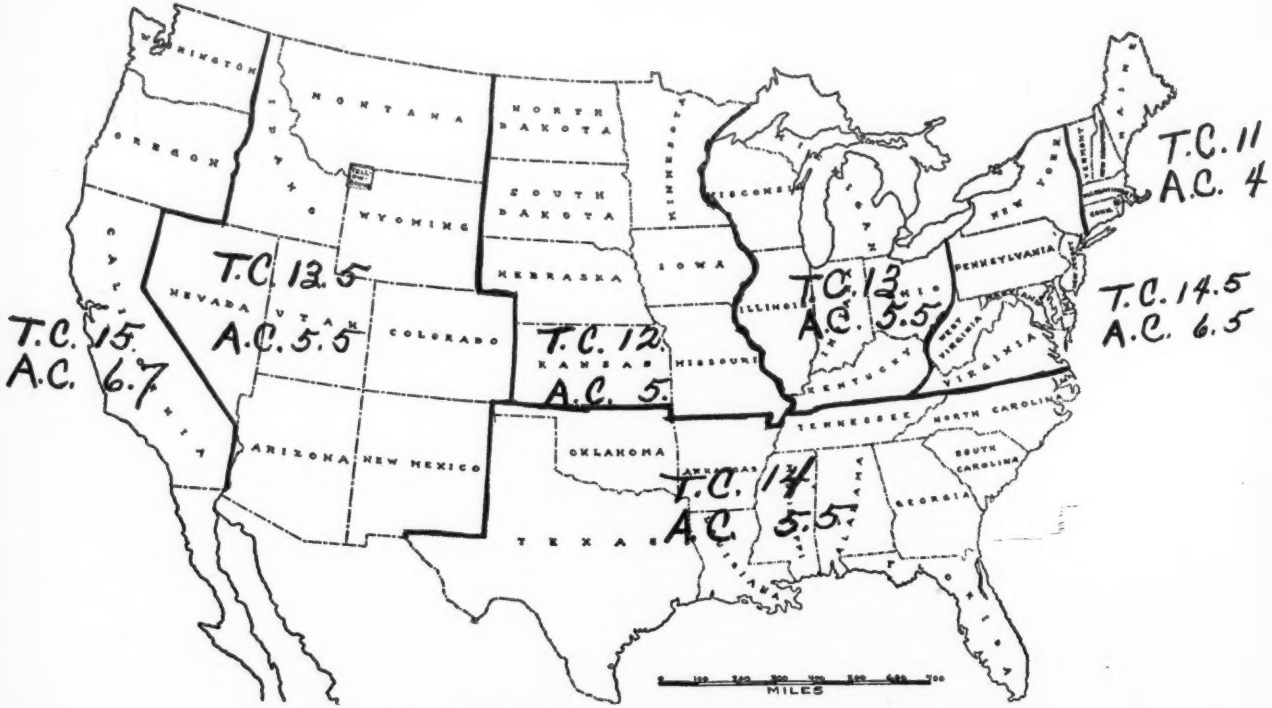
From the answers we find that 34 out of 42 schools give some kind of a separate soils course, apparently quite often given by an agronomy or similar department and not by a separate soils department.

10. *Do You Find the Textbooks Adequate? Discuss.*

Taking the answers from the questionnaire, 21 answered in the negative, 12 in the affirmative, and 4 considered the texts fair. From the discussion it is clear that those using straight organic and quantitative chemistry texts are in the main satisfied, while those attempting to teach applied work find the texts inadequate and in fact 2 or 3 have texts in the process of writing.

11. *Do You Think More or Less Chemistry Should Be Required of Agricultural Students? Discuss.*

The answers to this question must of necessity be more or less of a personal opinion and the results tempered by the fact that the answers are from chemists. Of the total answers 22 desired more chemistry, 3 less, and 11 were indifferent; an overwhelming demand for more when it is known that several classed as indifferent desired more chemistry for some



T. C. = Total Chemistry. A. C. = Advanced Chemistry

classes of students. In fact, several suggested that to answer this question correctly we would have to consider the type of work the student is to follow. Beyond doubt the answer to this question would be vastly different if others than chemistry teachers were offering their opinion. Of chief importance seems the fact that in the minds of chemists more chemistry could profitably be offered to agricultural students. Of additional interest also is the fact that nearly all of the indifferent answers were from schools giving more than the average amount of chemistry. In fact, only two such answers were secured from schools giving less than 12 hours of required chemistry.

12. *Should the Freshman Course Be Pandemic? Should the Second Year Be Pandemic?*

As a help to explain the type of work being given students, these two questions were included. The answers to the first one were about evenly divided, 15 favoring a pandemic course and 13 opposing. From the answers to the second part we find 23 opposed and only 7 in favor, answers much in keeping with the type of texts used in advanced course work, as shown by answers to question five.

15. *Do You Consider a Required Quantitative Course Desirable?*

This question has been partially answered in Kraybill's (see 5 in bibliography) article, still the figures are of interest. 26 expressed themselves as favoring a required course and 11 were opposed. This is about the same proportion as give quantitative analysis.

17. *Department of Agricultural Chemistry (Separate, United with Chemistry)*

The answers to this question are mainly of statistical value, although it might have some value in explaining the answers to some previous questions. From the answers it is found there are 16 separate departments of agricultural chemistry and the rest are united. This is from the 42 questionnaires returned.

18. *Number Teaching Agricultural Chemistry.*

This number ranges from 1 to 15 in one of the larger universities. Nearly a half reported only one teacher.

19. *Type of Work*
Full-Time Teaching
Part-Time Teaching, Part Research
Part-Time Teaching, Rest Extension, and Research.

From the answers to this question we find 15 places where the teachers regularly do both research and teaching, apparently most of the others have no regular research projects.

Discussion

The map is included in this article in place of detailed figures for states, giving the chemistry taught in each. It was felt that this map would give

teachers in any state some idea of how much chemistry neighboring states are requiring, which would have some importance since there is such a wide range from New England to the Pacific Coast states. Of interest, also, are some figures for schools which representative agricultural men on the campus here selected as the ten leading agricultural schools of the country. The average total chemistry requirement for this select group is 13.1 semester hours, 5 of which represent advanced chemistry.

In a questionnaire of this type it seems to me more desirable to let teachers draw their own conclusion rather than to attempt any elaborate summary which in the main must be chiefly a personal viewpoint. However, there are some facts which were shown by answers to the questionnaire which do not appear in the summary as given. The material which follows is the sum of these answers and personal talks with several teachers of chemistry.

First of all, there seems to be this question, "What is agricultural chemistry and what does it include?" Unquestionably this particular field seems to have early included mainly a study of soils and related topics. Now the trend seems to be more in the direction of physiological chemistry. So wide, however, is the field that it seems to me that the title "Agricultural Chemistry" must be applied to a group of studies rather than to any one subject. Even here the distinction is not great, problems in inorganic chemistry apply to farming today as well as organic ones. The use of sprays and dusts, the study of water supplies and the use of $KClO_3$ in killing weeds are all inorganic in nature, yet vital to the farmer as well as others, but neither necessarily organic or inorganic.

To me it seems, then, that we must designate as "Agricultural Chemistry" all of those fields of chemistry which either directly or indirectly help the farmer to increase his profits or better enjoy farm life and we must disregard the old lines of organic and inorganic chemistry. It would seem that the term agricultural chemistry as applied to any one particular course could well be dropped and specific names such as biological, nutritional, or physiological chemistry used.

Another point of particular interest is that relating to textbooks. Apparently there are a large number of schools which have only one semester or term for advanced chemistry. In it they must teach some fundamentals of organic chemistry and if possible, impart something of nutrition, physiology, and plant chemistry. Judging from the answers and discussions it is in this field that we most urgently need an up-to-date comprehensive text. A text which not only may be used in the classroom, but which when class is over the student will keep and use both in his other courses and after graduation. Illustrations and examples for such a text could readily be taken from practical agriculture. It would also seem that such a text should not be too brief if it is to be of value for a reference book.

Rather let the condensing be done by the teacher for certainly there will be a difference of opinion as to the particular topics to be taught.

A final question to be discussed is whether or not practical applications of chemistry shall be taught. Some department heads say they wish only the fundamentals taught, while others say they want everything taught that can be readily included. It would seem very desirable to have a survey made of various departments seeking to find just what chemistry they think their students need. Apparently much of our chemistry is taught from the standpoint of what the chemist thinks the student needs, rather than what persons in applied fields think they should have. Certainly a middle ground suitable to most could be found and this, it seems to me, should be our present aim.

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Waltzing Mice Used to Detect Monoxide Gas. Queer little Japanese waltzing mice have been put to good use by scientists who have found the mice even better than canary birds for detecting deadly carbon monoxide gas in the air, the U. S. Bureau of Mines has just reported.

Carbon monoxide is a highly fatal gas that has neither color nor odor, so that it can creep on a man unaware and overcome him almost before he knows what has happened to him. Small animals are affected more quickly than man by the same concentration of this death gas. Therefore, they have been used to detect the presence of the gas in the atmosphere of mines and other places where it is a menace.

The difference between the time when the animal is overcome and that when man will be overcome is sufficient to allow a man to return to fresh air, put on a mask or protect himself in some other way. However, the margin of time between effects in the animals and in men is not very wide and experience with canaries has shown that an occasional specimen may be tolerant enough to fail to exhibit symptoms before serious effects are incurred in men.

Because the effects of carbon monoxide poisoning are increased by physical activity, the waltzing mice, with their almost continuous and violent movements, show the effects of exposure to the gas much more quickly than any other animals and are therefore especially suitable for detecting the presence of the gas. They also recover very quickly from the effects of the gas, Bureau of Mines officials found.—*Science Service*

NEW LABORATORY PREPARATIONS FOR THE COURSE IN ORGANIC CHEMISTRY. I. DIETHYL CARBINOL FROM ETHYL FORMATE BY THE GRIGNARD REACTION

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Although a large number of teachers of organic chemistry use a formal, printed laboratory manual in their laboratory work, many prefer to select their own preparations from the material available in the various textbooks and in the chemical literature. Laboratory directions are handed out by them to the students in the form of looseleaf sheets which may be altered from year to year and which permit a certain flexibility in regard to the introduction of new material as it seems desirable. The author is strongly in favor of the latter method.

One important advantage to be gained by this method of laboratory instruction is the opportunity it affords to tie up the interests of the organic student with the research interests of the instructor or with the newer developments in the organic chemical literature of the present day. This may be accomplished either through a class preparation run parallel to similar work in the research laboratory or through the use of methods which illustrate current work in the research laboratory. At the same time, it may furnish the instructor with a source of his research intermediates. The development of such an interest in research at this time in the educational growth of the student is often of lasting value.

As a by-product of these attempts to relate the teaching and research functions, several uncommon or very satisfactory laboratory preparations for general student use have been worked out and the first of these is described in this report.

Preparation of Diethyl Carbinol

One of the research problems being carried on in the laboratory of the author is connected with the mechanism of the action of sodium on secondary and tertiary alkyl halides. The sources of these halides are the corresponding alcohols and in the case of the secondary alcohols of higher molecular weight, it is necessary to synthesize these. The most satisfactory method in general is the Grignard reaction.

Thus diethyl carbinol can be prepared by the action of ethyl magnesium bromide and ethyl formate. Since the materials are inexpensive and the yields good, the method was turned over to the undergraduate class for study.

General Directions.—The method used is essentially that of Grignard,[1] who treated two equivalents of ethyl magnesium bromide in ether with one equivalent of ethyl formate in ether, and decomposed the intermediate compound with a dilute acid solution.

[1] Grignard, *Compt. rend.*, **132**, 336 (1901); *Ann. Chim.*, **24**, 433 (1901).

Materials Used.—Ethyl bromide, EK, dried over calcium chloride; ethyl formate, EK, dried over "dry" potassium carbonate; diethyl ether, CP, dried over calcium chloride and then over sodium; magnesium turnings.

Directions for the Student.—To a 500-cc. round-bottom, short ring-neck flask containing 12 grams (0.5 mol) of dry magnesium turnings, attach your addition tube equipped with a dropping funnel and a long reflux condenser (20–24 inches). The dropping funnel is closed at the top with a calcium chloride tube to prevent the entrance of moisture and for the same reason the inner tube of the condenser must be perfectly dry. After adding 60 cc. of dry ether to the magnesium in the flask, place a solution of 45 cc. (0.6 mol) of ethyl bromide and 30 cc. of ether in the funnel, close the funnel with the drying tube and add the mixture slowly to the contents of the flask. The reaction should start after the addition of a small amount of the mixture; in case it does not, add a crystal of iodine. It may be necessary to slow up the reaction by immersing the flask in a cold water bath.

After the reaction is well started, add 125 cc. of ether carefully through the condenser. Since an excess of ethyl bromide is used, the magnesium should go completely into solution. When this is the case, cool the contents of flask with a cold water- or ice-bath, and add cautiously, and with shaking after each addition, a solution of 20 cc. (0.25 mol) of ethyl formate and an equal volume of ether. The reaction is complete in a short time to give a bluish grey, viscous solution.

Now cautiously decompose the addition product by adding slowly through the funnel 50 cc. of water; shake well while adding. Then slowly add a cooled solution of 16 cc. (0.3 mol) of concentrated sulfuric acid in 100 cc. of water. When all the acid solution is added and the greyish precipitate largely dissolved, separate the ethereal layer, dry with "dry" potassium carbonate and fractionally distil, taking the fractions (1) up to 50°, (2) from 50–100°, and (3) from 100–116°. Determine the refractive indices of these fractions and compare with those found or listed for the materials used and the one listed in the Critical Tables for diethyl carbinol. (What substances may be in these fractions?) Redistil the last fraction, taking the diethyl carbinol between 113–116°. Calculate your yield from the ethyl formate used.

Discussion of Results

Twenty student preparations and three by the instructor using identical directions resulted in yields running from 37–71 per cent. The yield depends largely on two factors: the dryness of apparatus and materials and care used in fractionation. The average for the class was 57% and for the instructor, 70%. Careful fractionation of the ether recovered in

all the preparations, using a five-foot special column, gave up sufficient diethyl carbinol to bring up the average yield of each group 8%.

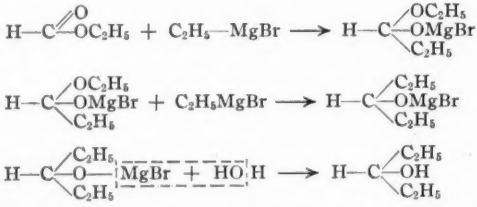
The diethyl carbinol thus prepared has a boiling point of 113–115°, and n_D^{20} of 1.4110.

Ether for use in this preparation may be prepared from the laboratory CP grade by drying over calcium chloride and then over sodium. There is some advantage to be gained in distilling this last product over phosphorus pentoxide. Good results are obtained with the halide dried over calcium chloride and decanted and with ester dried over "dry" potassium carbonate and decanted and distilled.

The main student difficulty added to these two factors appears to be a lack of sufficient agitation during the addition of the ester solution. The lighter ester tends to collect and float unless shaken after each addition; if enough thus collects, it reacts with violence when the mixture is next agitated and some material will be lost through the condenser.

The Mechanism of the Reaction

Grignard in his early articles[1] has postulated the reaction as taking place in three steps.



(1)

(2)

(3)

The by-product in (2) is C_2H_5-OMgBr and in (3) is Mg(OH)Br. (Sulfuric acid is added to dissolve this latter.) These equations will be found in a number of textbooks.[2]

Reformatsky[3] and a number of others have more recently suggested that in this reaction an aldehyde or ketone is formed as an intermediate product and that the alcohol results from this by hydrogenation.

[2] Porter, "Carbon Compounds," rev. ed., p. 417. Cohen, "Organic Chemistry," **1919**, pt. I, p. 211.

[3] Reformatsky, *J. Russ. Phys. Chem. Soc.*, **37**, 881 (1905). Stadnikoff, *Ber.*, **47**, 2133 (1914); **57**, 1–8 (1924). Boyd and Hatt, *J. Chem. Soc.*, **1927**, 898–909.

Rubalt. Rubalt is a new waterproof, rustproof, and acid-resistant paint of rubber, bitumen, and benzene. It is a retardant of various types of corrosion. The sulfur is removed from the bitumen, which is then combined with the rubber by a special process. Other ingredients are added which have a tendency to make the paint dry rapidly and produce a lustrous enamel finish.—*Ind. Eng. Chem., News Ed.*

MICHAEL FARADAY NO LONGER WASHES APPARATUS FOR SIR HUMPHRY DAVY AT THE CHEMISTS' CLUB

The accompanying picture has appeared twice in the JOURNAL, once as the frontispiece to the September, 1925, number and once in connection with an article on page 1231 of the October, 1928, number. A note in *The Chemical Age* for January 4, 1930, has called our attention to the fact that this illustration has been erroneously titled and we are herewith calling the correction to the attention of our readers.

A Picture Called "The Laboratory"—An Unfounded Faraday Tradition

The Chemists' Club, New York, has a picture, now hanging in the library, presented many years ago by the late Charles F. Chandler, who purchased it in England. It has always been the tradition that the picture represents "Michael Faraday Washing Laboratory Apparatus for Sir Humphry Davy." Like so many traditions, this one, too, proves to be an idle dream. Here is the story as told by Dr. Arthur D. Little and published in *The Percolator*, the Club journal:

"It happened that Dr. Francis H. Carr came to my laboratory when in this country a year ago. He then expressed doubt concerning the legend of the picture and later went to great pains to get the authentic story, which I now send you on the enclosed sheet. I am darn sorry he did it, for I hate to see a pretty tradition shattered, but in the interests of truth, for which we chemists entertain such scrupulous respect, I send the story on to you. While I was in London I was taken over the Royal Institution and down into Faraday's laboratory. I found as a matter of fact that it bore no resemblance to the picture and was lighted only by a large window facing a whitewashed brick wall only a few feet away."

Dr. Carr, in a note on the engraving of the picture by W. Hunt, entitled "The Laboratory," states:

"This depicts the premises of Jacob Bell in Oxford Street (London). Beyond the laboratory is the shop, and through the entrance door of the shop may be seen Great Portland Street. An account of the picture is given in *The Chemist and Druggist* for July 30, 1898, according to which the old man in the engraving was John Simmonds, who was a shopman to John Bell in 1806. He remained with the firm until a hoary old age, to be immortalized in Hunt's water color drawing of 'The Laboratory.' The name of the boy was William. There seems little reason to believe the truth of the allegation that the picture depicts Michael Faraday washing apparatus for Sir Humphry Davy."

The only person in life who is effectively original is he who has a routine and has mastered a technic. The one who has not these is a slave—his life is taken up in trying to keep up with the procession.

The Chemistry Student

SOME ELEMENTARY PRINCIPLES OF X-RAY CRYSTAL ANALYSIS. II

OTTO REINMUTH, ASSOCIATE EDITOR

Preliminary Summary

In the first article of this series[1] we demonstrated that (with certain important reservations) crystal planes may be considered as mirrors which "reflect" X-rays. We considered the conditions under which such "reflection" may take place and we defined those conditions mathematically. We showed that, having ascertained the structure of a crystal, we can calculate the dimensions of its unit cell. Knowing the dimensions of the unit cell of a crystal, we can calculate the wave-length of incident X-rays. Finally, we made note of the principles underlying several different experimental procedures, with the intention of examining them in more detail later on.

In order to become a little more familiar with the manner in which crystal planes reflect X-rays, let us continue for the present to work backward. More specifically, let us temporarily accept on faith the established structures of two common and very simple crystals and see what we can learn from the various X-ray patterns which they can be made to produce. The crystals which we shall use are NaCl and KCl. The unit cube of either may be represented as in Figure 10 on p. 147 of the preceding article.

The Designation of Planes

We have already taken note of the fact that any regular arrangement of points such as a crystal lattice comprises a very large number of sets of parallel planes (see Figure 11, p. 149, preceding article). If we are to discuss diverse sets of planes intelligently, it is essential that we have some definite system for designating them. The system universally employed for crystals which can be described by means of rectangular coördinates is illustrated in Figure 12.

Choosing a corner of the unit cube as the origin, O, we lay off the familiar geometrical x, y, and z coördinates. Still following the usual convention, the projections of these coördinates through the origin are designated as $-x$, $-y$, and $-z$, respectively. In crystallography these coördinates are commonly called a, b, c, $-a$, $-b$, and $-c$, respectively. We can now describe any set of planes in the cubic lattice by three integers, hkl. The number of equal parts into which the set of planes divides the cube edge

[1] THIS JOURNAL, **7**, 138–50 (Jan., 1930).

corresponding to the x (or a) axis is h; the number of equal divisions on the edge corresponding to the y (or b) axis is k; on the edge corresponding to the z (or c) axis it is l. The corresponding numbers for the negative coördinates are: for $-x$, $\bar{h}$; for $-y$, $\bar{k}$; and for $-z$, $\bar{l}$. Thus in the upper right-hand corner of Figure 12 we see represented the (231) planes. These divide the x axis into two equal parts ($h = 2$), the y axis into three equal parts ($k = 3$), and the z axis into one part ($l = 1$). The planes diagrammed at the lower left-hand corner of Figure 12 divide the $-x$ axis into two parts ($\bar{h} = \bar{2}$), the $-y$ axis into three parts ($\bar{k} = \bar{3}$), and the z axis into one part ($l = 1$). Other analogous sets of planes are illustrated at the remaining corners of Figure 12.

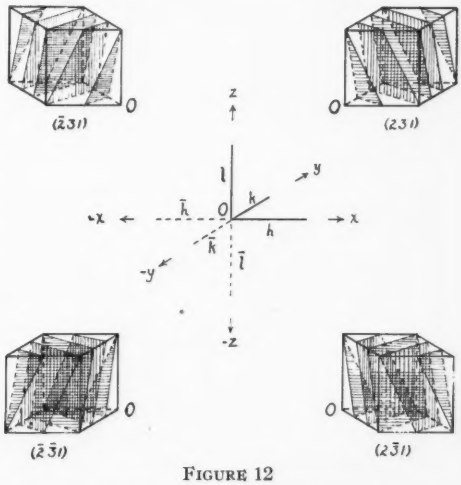


FIGURE 12

Authors are not always consistent with each other, or even self-consistent, in the choice of origins and coördinates. A very common convention is that which would be obtained by rotating the central diagram shown here 90° to the left. Except that it is confusing to the beginners, this arbitrary choice is not a matter of great importance. All diagrams accompanying this article are consistent with this figure.

The method of ascribing indices is sometimes described in a somewhat different manner, but either definition leads to the same results. The following quotation is from Wyckoff: "These indices are obtained by taking the numerators of the reciprocals of the intercepts (chosen as multiples of the unit axial lengths) on the three coördinate axes of reference when these reciprocals have been reduced to a lowest common denominator."

When a set of planes fails to intersect a given axis at all (*i. e.*, when the planes are parallel to that axis), the number for that axis is 0. (See (200), (220), (202), etc., diagrams in Figure 18.) Thus the planes constituting the faces of a cube may be designated as (100), (010), and (001).

The student can quickly familiarize himself with this system of nomenclature by drawing skeleton cubes, choosing an origin, dividing the axes into various numbers of equal parts, and connecting the points so obtained to outline the respective sets of planes. It is also good practice to take a prepared diagram (like one of those here presented) and choose successive corners of the cube as origin, renaming the planes each time in accordance with the shift in origin. Thus if we shift the origin of the (231) diagram from the near, lower, left-hand corner to the far, upper, right-hand corner we shall then have to call our planes ($\bar{2}\bar{3}1$). This illustrates the rule that by changing

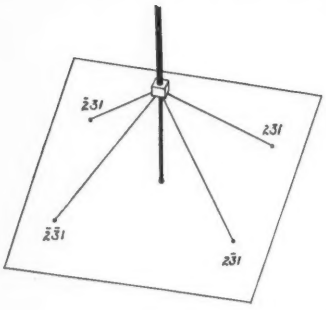


FIGURE 13

the signs of *all* the indices of a set of cubic planes at once, we merely produce the geometrical extensions of the original planes.

The Laue Pattern

It is evident from Figure 12 that if a beam of "white" X-rays, containing a sufficient range of wave-lengths to include one or more which satisfy the requirement $n\lambda = 2d \sin\theta$, is directed normal to a cube face of a NaCl crystal a given family of planes should give rise to four "reflections." (See Figure 13.) Not every family of planes present will "reflect," for not all families will find proper wave-lengths to satisfy the conditions imposed by Bragg's equation. Some "reflections" will be at such angles as to throw them outside the recording film and consequently they will

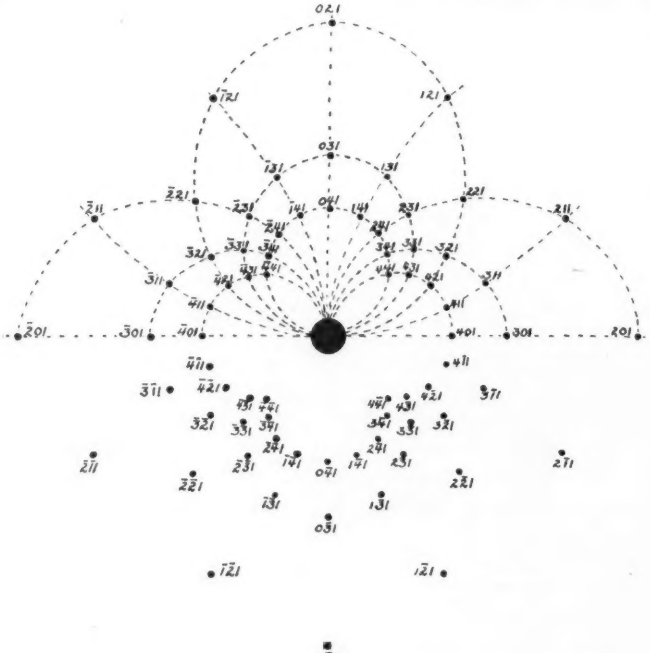


FIGURE 14.—LAUE PATTERN OF NaCl. TAKEN WITH INCIDENT RAYS NORMAL TO A CUBE FACE

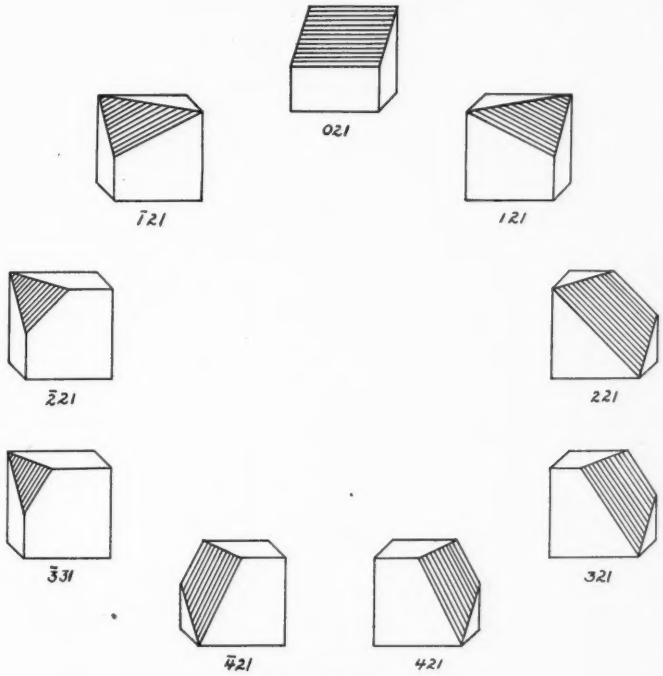


FIGURE 15

To gain the proper impression it is necessary to imagine that one is looking almost directly down upon a collection of cubes. Each cube has been cut away to show one member of the set of planes indicated.

produce no spots on the pattern. Nevertheless, there will be a large number of families of planes which will give rise to recorded "reflections."

In Figure 14 we have a diagram of a Laue photograph of NaCl, taken with the incident beam normal to a cube face. Each spot is numbered to designate the set of planes producing it. The student will note that the four spots corresponding to any given family of planes [*e. g.* (231), ($2\bar{3}1$), ($\bar{2}\bar{3}1$), and ($\bar{2}31$)] lie at the corners of a rectangle, as would be expected from geometrical considerations. He will also note, by observing the dotted lines sketched into the upper half of the diagram, that there is an elliptical arrangement of spots. This also is readily explainable on geometrical grounds.

Let us take, for example, the largest complete ellipse in the diagram. It includes the (421), (321), (221), (121), (021), ($\bar{1}21$), ($\bar{2}21$), ($\bar{3}21$), and ($\bar{4}21$) spots. If the student can visualize the corresponding planes with the aid of Figure 15 he will note that, taking them in rotation, the effect

is much the same as though a single inclined plane were rotated through a definite number of positions about an inclined axis which lies in the plane.

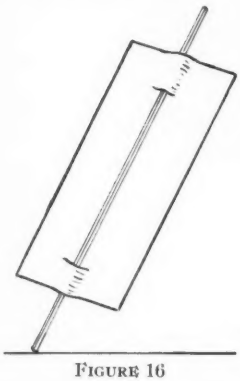


FIGURE 16

In order to visualize the rotation process more clearly the student may thread a stiff piece of wire through a blotter or card after the manner shown in Figure 16. If the wire is held at a constant angle to the vertical and the card is rotated through a number of positions about the wire as an axis, the effect produced will be similar to that which we are trying to describe.

Keeping in mind the fact that X-rays are "reflected" from a plane at an angle equal to the angle of incidence, the student can satisfy himself that the "reflected" rays from such a series of planes as we have been considering will outline a cone. However, the axis of the cone is not normal to the recording film, but is inclined at an angle. Hence the cross-section of the cone where the film intercepts it is not a circle but an ellipse. We have, as a consequence, the elliptical arrangement of spots which we note in the Laue pattern.

So much for the production of the Laue pattern for the present. If we compare Laue patterns of NaCl and KCl we notice no difference between them so far as the number or general arrangement of spots are concerned, although there is, of course, a difference in spacing, and we may also detect differences in the intensities of corresponding spots on the two patterns. Since we have all along assumed that these two crystals have the same structure and that their unit cubes differ only in dimensions there is on first thought nothing remarkable in the fact that their patterns are alike. A little later we shall see that this circumstance requires explanation.

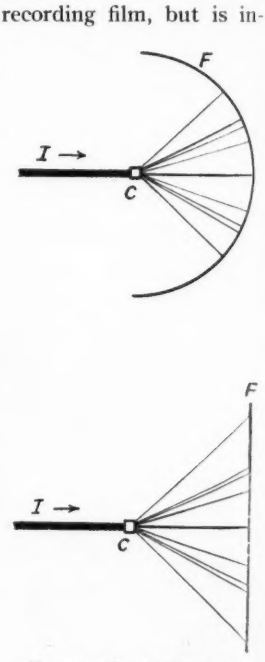


FIGURE 17.—I, INCIDENT BEAM; C, CRYSTAL; F, FILM

The Bragg Method

Just now let us turn our attention to the Bragg method. Following this procedure, the reader will recall, we mount a single crystal so that it may be rotated about some important crystal axis. A beam of *mono-*

chromatic X-rays is then directed against the crystal perpendicular to the axis of rotation. As the crystal is rotated about the chosen axis various sets of planes successively come into positions which provide for the satisfaction of the condition, $n\lambda = 2d \sin \theta$. The "reflected" rays are recorded on a photographic film which may be either flat or curved. (Figure 17.) The positions of the spots upon the film will differ somewhat, depending upon which form of film is used. The diagrams which we shall employ are projected upon flat surfaces.

As an aid toward the visualization of this process, we have sketched, in Figure 18, a number of theoretically possible sets of planes. If we set a cube of NaCl upon one of its faces and rotate it about a vertical axis (which is to say, about a cube edge), we shall obtain a pattern of which the upper right-hand quadrant is shown in Figure 19A. Viewing this pattern in conjunction with some of the diagrams set forth in Figure 18 it is easy to see why the "reflections" are directed approximately as they are. The vertical sets of planes, such as (200) and (220), give "reflections" which are recorded along a horizontal axis through the center of the pattern. The "reflections" from more widely spaced sets, *e. g.* (200), are relatively nearer to the center of the diagram; as the spacing decreases, *cf.* (220), the "reflection" spots are found farther out along the axis. The "reflection" of the upward-inclined and widely spaced (111) set is found above and to the right of the center; the more closely spaced and somewhat less inclined (311) set leaves its mark a trifle more above the center, and considerably farther to the right. The (222) set, inclined at the same angle as the (111) set but more closely spaced, gives a spot above and to the right of the (111) spot.

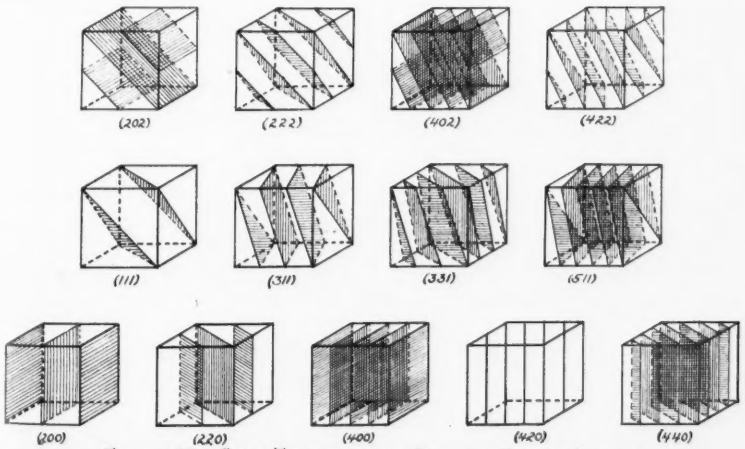


FIGURE 18.—SOME THEORETICALLY POSSIBLE SETS OF PLANES

But now we are headed for difficulties. If we compare the pattern for NaCl (Figure 19A) with that for KCl (Figure 19B) we see that certain spots present on the former are absent on the latter. Furthermore, we note that even on the NaCl pattern these spots, (111), (311), are relatively weak.

We shall make better progress in solving this enigma if, instead of asking why certain spots are missing from the KCl pattern, we inquire why those spots are present at all on the NaCl pattern. Let us begin by examining the (111) set of planes, for what we shall find out about it can also be applied to the (311) set.

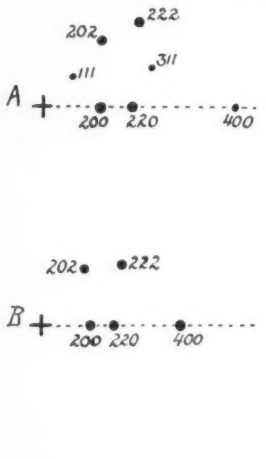


FIGURE 19.—A, QUADRANT FROM CUBE EDGE ROTATION PATTERN FROM NaCl; B, SIMILAR PATTERN FROM KCl; C, SIMILAR PATTERN FROM HYPOTHETICAL SIMPLE CUBE OF HALF THE DIMENSIONS OF KCl

Examining the (111) diagram in Figure 18 in conjunction with the NaCl unit cell diagram (Figure 10, p. 147, preceding article), we perceive that all (111) planes are made up of one kind of ions, and that they are interleaved by parallel planes made up entirely of the other kind of ions. The central column of Figure 20 shows the plan views of two adjacent (111) planes, together with a side view indicating the interleaving.

In the beginning we had, therefore, no right to suppose (111) planes for this crystal at all, for when a (111) set is equidistantly interleaved in this fashion, we get a (222) set. Any radiation, then, which could give a first-order "reflection" for a true (111) set would find itself giving a half-order "reflection" for (222), which amounts to total opposition between successive reflected rays.

The reader will recall that for "reflection" to take place $n\lambda$ must equal $2d \sin\theta$. Here n represents the "order of the reflection" and must be a whole number. (*Cf.* SUMMARY, pp. 145–6, and Figures 9A and 9B, preceding article.) The reader can verify the last statement in the foregoing paragraph either by constructing for himself the appropriate diagrams or by consideration of the equation itself. It is obvious that if λ and θ remain unchanged, halving d (the distance between planes) must result in halving n (the order of the reflection). If n is other than an even number, total opposition (*i. e.*, interference) between "reflected" rays must result.

The fact remains, however, that our NaCl pattern does contain a (111) spot. How shall we account for it?

The catch lies in the fact that all ions or atoms do not refract X-rays

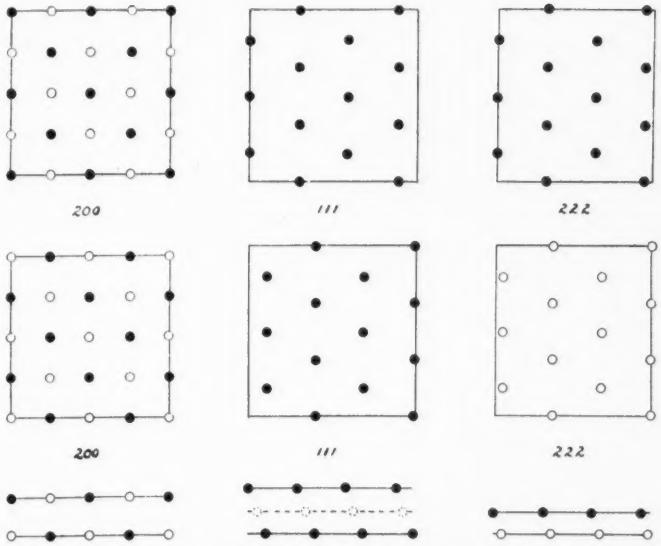


FIGURE 20.—SOME ROCKSALT PLANES

equally. The scattering power of an ion is roughly (though not exactly) proportional to its atomic number.[2] A plane made up entirely of Na ions (N = 10) could not "reflect" so intense a beam as a plane made up entirely of chlorine ions (N = 18). Therefore, although the Na-"reflected" beam is totally opposed to the Cl-"reflected" beam in the case of a first-order (111) "reflection," total extinction does not occur. There is a residual effect which manifests itself in a relatively faint (111) spot. The same line of reasoning applies, of course, to the (311) spot.

In KCl, however, we have two ions of the same atomic number (N = 18), so that there is no appreciable residual effect when their respective "reflections" are in opposition and spots like (111) and (311) fail to appear in its pattern.

As a matter of fact, there are no odd-numbered spots at all in the KCl pattern. The NaCl pattern shows only the spots for which the index numbers are either all odd or all even, 0 being counted as even. The latter rule is sometimes stated in a somewhat different form, which amounts to the same thing. Possible spots for NaCl have index numbers such that: $h + k$, $h + l$, and $k + l$, are all even. These sound like empirical rules, as indeed they are, but if the reader can visualize, or will take the

[2] The reason for this is made clearer by reference to Figure 2 and accompanying text, p. 140, of the preceding article.

trouble to diagram, a few sets of planes, he will soon recognize the physical basis underlying them.

NaCl gives the pattern which is characteristic of face-centered cubic crystals. KCl is really an anomaly. If we divide the indices of all the KCl spots by two (which we can do since they must all be even), we obtain the indices which are characteristic of a simple cubic structure of one-half the KCl dimensions. This is to say that KCl acts with respect to X-rays as though its unit cube were one of the eight smaller cubes which make up the true unit cube depicted in Figure 10.

Before we leave off considering the Bragg method, let us note one more detail. We see by Figures 19A and 19B that NaCl and KCl both give a (400) "reflection." Yet when we compare the (400) diagram in Figure 18 with the unit cube in Figure 10, we see that neither NaCl nor KCl can have a (400) set of planes, for there are no lattice points to constitute such planes. As a matter of fact the (400) spots in these Bragg patterns are not first-order "reflections" of (400) sets, but second-order "reflections" from (200) sets. Figure 21 explains why the effect of second-order "reflection" from (200) sets is similar to that which would be expected of first-order reflection from (400) sets. The explanation is general for all analogous cases.

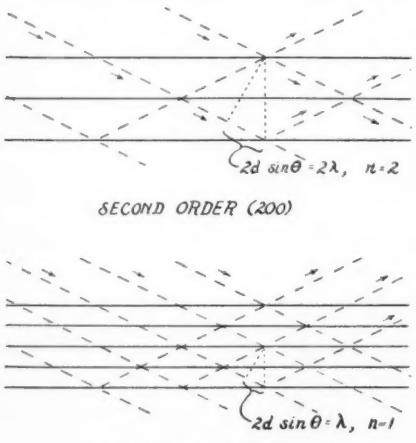


FIGURE 21

At this point let us return to a question of which a hint was dropped earlier in the present discussion. Why, if the Bragg rotation patterns of KCl and NaCl differ, do not the Laue patterns differ also? The answer lies in the fact that the various orders of "reflection" are not separated in the Laue pattern, but are superimposed one upon another. This difference arises out of the fundamental differences between the two methods.

In the Laue method the crystal remains in a fixed position. This is to say that for all planes oriented in any given direction θ remains constant. The wave-length, however, in effect varies. Since θ remains constant, the direction of the "reflected" beam must also remain constant, and beams of more than one wave-length are "reflected" along the same

path. The upper and central diagrams of Figure 22 are cited in illustration of these statements.

In producing the Bragg pattern, on the other hand, we use "monochromatic" rays, which is to say that λ remains constant. The crystal itself is rotated so that θ varies. Since θ varies, the deflections of the "reflected" beams must also vary and we find the different orders separated on the pattern. The central and lower diagrams of Figure 22 illustrate this.

The Powder Method

We shall find it convenient to approach our discussion of the powder method by way of a consideration of the complete Bragg diagram. In the production of such diagrams we are not limited to rotation of a crystal about a single axis. We may choose any one, or a number of, important cube directions for axes. In Figure 23 the complete patterns for KCl and NaCl rotated about three different axes are diagrammed.

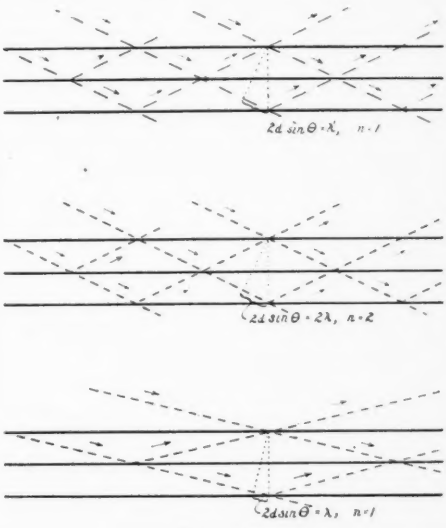


FIGURE 22

One notes at once that the spots are distributed upon a series of concentric circles.[3] Reflections from various plane groupings fall always on these circles, although not always in the same positions on the circles. (Compare 23A with 23B and 23D with 23E.) If we superimpose these patterns as we have done in Figures 24A and 24B, the circular orientation of spots is even more striking.

The reader can easily satisfy himself by the construction of appropriate diagrams or the manipulation of appropriate models that the loci of reflections from various plane groupings when those groupings are moved through all positions which satisfy the condition, $n\lambda = 2d \sin\theta$, constitute a series of concentric cones whose axes are normal to the flat recording film. The intercepts of the cones upon the film are, of course, circles.

[3] This is true, of course, only if the pattern is recorded upon a flat film. If a cylindrical film is used, the spots fall upon closed curves which are neither circles nor ellipses.

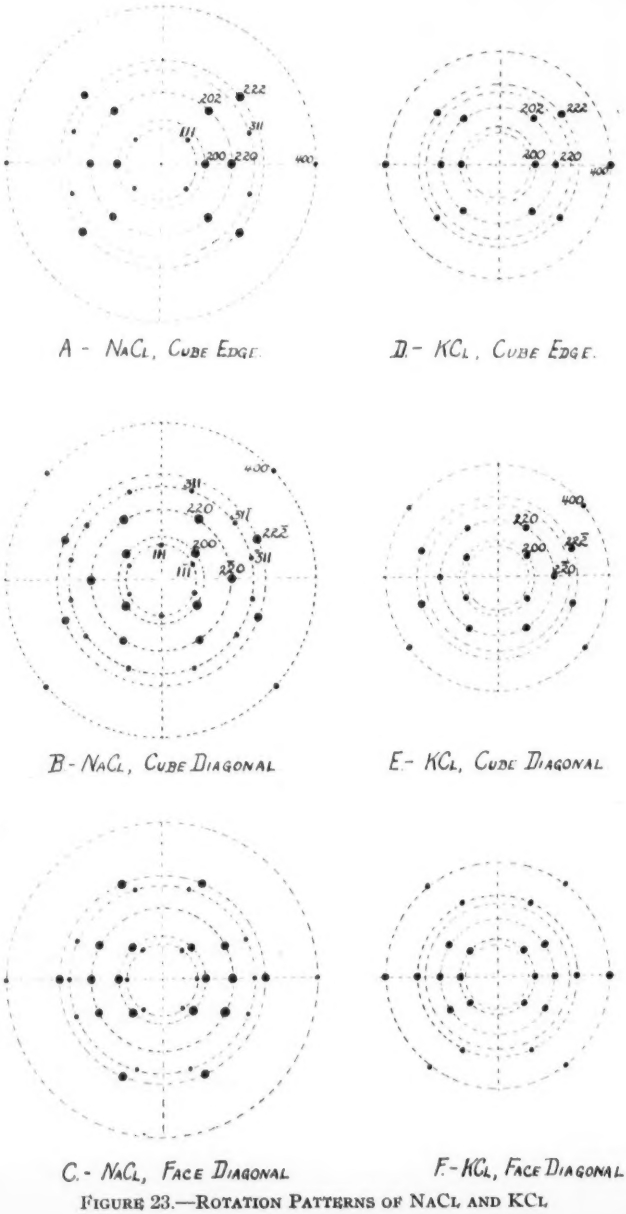


FIGURE 23.—ROTATION PATTERNS OF NaCl AND KCl

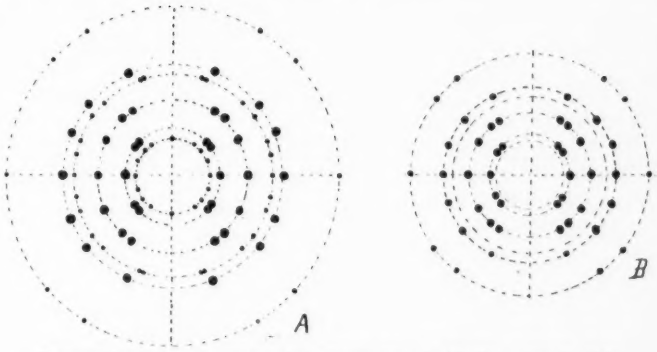


FIGURE 24.—SUPERIMPOSED PATTERNS OF: A, NaCl; AND B, KCl

Successive rotations of the crystals about three axes have carried the various sets of planes recorded through only a relatively limited number of possible orientations. Yet when we superimpose the diagrams we see that the various reflection spots have already outlined circles very clearly. If it were possible to obtain an infinite number of different plane orientations, we should expect the spots to spread out into continuous circular lines. This, in effect, is what the powder method accomplishes[4] and the resultant patterns are diagrammed in Figure 25.

Figure 25A is the characteristic powder pattern for a face-centered

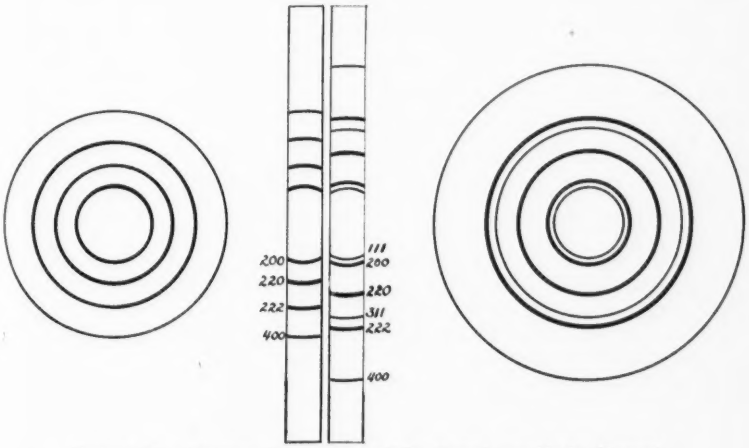


FIGURE 25.—POWDER PATTERNS OF KCl (LEFT) AND NaCl (RIGHT)

[4] The reader can refresh his memory on this point if necessary by referring to p. 149 of the preceding article.

cubic structure. Figure 25B is, if the indices are halved, the characteristic powder pattern for a simple cubic structure of half the dimensions of the KCl unit cube.

Acknowledgment

The writer desires to express gratitude to Dr. Emil Ott of The Johns Hopkins University for reviewing this manuscript and to Miss Marguerite Little of the JOURNAL staff for aid in preparing some of the illustrative diagrams employed.

He also acknowledges his indebtedness to the following references:

W. P. Davey, "Study of Crystal Structure and Its Applications," *Gen. Elec. Rev.*, **27,** 742–8, 795–802 (1924); **28,** 129–37, 258–65, 342–8, 586–99, 721–30 (1925); **29,** 118–28, 274–87, 580–9 (1926).

Sir William Bragg, "An Introduction to Crystal Analysis," D. Van Nostrand Co., Inc., New York, American edition, **1929.** (A number of the diagrams employed are after Bragg, with slight modification.)

R. W. G. Wyckoff, "The Structure of Crystals," The Chemical Catalog Co., Inc., New York, **1924.**

George L. Clark, "Applied X-Rays," McGraw-Hill Book Co., Inc., New York, first edition, **1927.**

F. K. Richtmyer, "Introduction to Modern Physics," McGraw-Hill Book Co., Inc., New York, first edition, **1928,** Chapter XII.

Centenary of Das Chemische Zentralblatt. On Jan. 14, 1830, appeared the first number of *Das chemische Zentralblatt,* which at that time was also designated *Das pharmaceutische Centralblatt.* The centenary of this well-known reference work was marked by the delivery of an address to the German Chemical Society by Dr. Maximilian Pflücke on Nov. 11, 1929. The address, which is published at length in the December issue of the *Berichte der Deutschen Chemischen Gesellschaft,* deals with the early history and subsequent development of the journal. The original purpose of the undertaking was to provide pharmacists with an accurate survey of the new and important facts of interest to them which were being discovered not only in Germany but also in France, England, Holland, and Italy. At first the issue was fortnightly, but ever since September of the first year of publication it has appeared weekly in spite of the enormous difficulties arising from the War. The extraordinary growth of the work can be gaged from the fact that the number of abstracts in the first volume amounts to about one per cent of those now appearing annually, and many of the original sources are now obsolete. The first editor, Herr Gustav Theodor Fechner, was able to undertake the whole survey himself. One of his earliest problems was apparently connected with nomenclature, and he decided to be guided by the system of Berzelius. After several changes, the editorship passed into the hands of Prof. Rudolf Arendt in 1862, who guided its destiny for about forty years. So successful was the work under his direction that in 1895 the German Chemical Society decided to take over the management, and shortly after Arendt's death in 1902 the headquarters were moved from Leipzig to the newly established Hofmann-Haus in Berlin.—*Nature*

RESTORING THE PANAMA MURAL PAINTINGS

ALBERT B. NEWMAN, COOPER UNION, NEW YORK CITY

During the construction of the Panama Canal, the late General George W. Goethals, then Colonel and in charge of the project, commissioned Mr. W. B. Van Ingen, the mural painter, to execute a set of mural paintings telling the story of the construction. These paintings were to be placed on the curved side walls of the rotunda in the Government Administration Building, Balboa Heights, Canal Zone. Before executing the paintings in New York, Mr. Van Ingen spent about six months at the canal site, studying the construction operations, making sketches and receiving criticisms and suggestions from Colonel Goethals. Finally the Colonel gave the word that the sketches were satisfying to him from the standpoint both of the scope of construction operations portrayed and of the correctness of detail, and the artist was authorized to proceed with the canvasses. He then produced a set of pictures achieving the rare combination of high artistic merit and engineering accuracy. If these pictures should be destroyed, they could not well be replaced, owing to the fact that much of the detail shown is now under water and the fact that the events shown have passed into history.

Late in 1928, the Governor of the Canal Zone advised Mr. Van Ingen that the paintings had been attacked by the mold growths which are so prevalent in tropical regions, and requested him to visit the Zone to discuss what measures might be taken to restore the paintings to their original condition and to protect them against future attacks. Before sailing from New York, Mr. Van Ingen discussed the matter with the writer, and a number of tentative suggestions were made to assist him in discussing the matter more intelligently upon his arrival. The first fact to be considered was that the paintings were permanently attached to the walls. That eliminated consideration of any procedure which would involve fumigating with vapors toxic to the mold. The first off-hand suggestion was to apply a fungicidal wash, retouch any affected paint areas, and then to coat the clean surface with paraffin to which a small percentage of cresol had been added. It was realized that the use of cresol was open to objection on account of odor and low melting point, and that some other member of the phenol family having more suitable properties might be found. There was insufficient time to make a study of these matters. Mr. Van Ingen visited the Canal Zone during December and returned with cultures of the mold and with instructions to get the details of a procedure worked out with a view to negotiating a contract with the Government covering the restoration of the paintings.

In a letter to Mr. Van Ingen, Dr. Lewis T. Bates, Chief of the Board of Health Laboratory of the Panama Canal, quotes from his laboratory records as follows:

Dec. 20, 1928. Mold from Mural Paintings in Rotunda of Administration Building, Balboa Heights, C. Z. Specimens removed under the direction and in the presence of Mr. W. B. Van Ingen, the artist who originally painted the pictures.

These paintings have many areas showing considerable growth of mildew. In most places the individual growths of the mildew are about the size of the head of a pin. They are white in color. They cannot be brushed off, they cannot be rubbed off, and they cannot be removed by gentle scraping. The only way to remove them seems to be by scraping with hard pressure taking off considerable paint at the same time and by digging them out with the point of the scalpel.

In this latter manner enough mold was removed to inoculate four tubes of Sabouraud's media (two from the east wall and two from the west wall), and four plain agar slants (two from the east wall and two from the west wall). Two of the tubes of Sabouraud's media and two of the plain agar were delivered to Mr. Van Ingen to take to the United States. Two small tubes containing a small amount of the scrapings from each side were also delivered to Mr. Van Ingen.

In a cover slip preparation of the mold examined under the microscope many ascospores could be seen.

The mold cultures were submitted by the artist to Dr. Charles Thom, Principal Mycologist of the Bureau of Chemistry and Soils, U. S. Department of Agriculture, at Washington, who wrote the following:

Several organisms were present in the cultures but most of them were regarded as non-significant, merely incidentally present. One of these cultures, however, produced extensive growth covering the entire culture medium in our petri dishes, giving an extensive mycelium in the substratum and upon the surface of the substratum, hyphae colored brown or greenish brown. Thus far I have discovered no spores which would permit of botanical identification. The general group to which it would be assigned as a hyphomycete contains a series of species with these brown heavy walls capable of growing in situations alternately wet and dry, capable of drying up without perishing and resuming activity whenever the moisture conditions become favorable. This organism suggests by its habits and appearance, that it belongs among this series of species, some of which one or two of my colleagues have already studied in connection with painted surfaces.

Elimination of such organisms may be reached by (1) permanent drying of the substratum; (2) the penetration of the substratum by some substance which will not permit access to the nutrients on the part of the mold; (3) the soaking or penetration of the substratum with some disinfectant or antiseptic which will remain there and become soluble in minute quantities every time there is access of moisture, thus tend to prevent mold growth.

Without first-hand experience with a paint problem in the tropics we are not in a position to settle which is the best line of procedure.

The writer thought that there must be many sources of information about work of this kind and, inasmuch as the nature of the problem was foreign to anything in his previous experience, he encouraged the artist to get what information he could from local museums of art and from publications in the art field. He obtained little information from persons whom he consulted in New York and the publications were of a semi-scientific nature requiring interpretation for one without chemical training. Owing

to these difficulties and on account of the connection of both the writer and the artist with the Cooper Union for the Advancement of Science and Art, the writer decided, somewhat reluctantly, to take the responsibility of guiding Mr. Van Ingen in establishing a procedure. It was definitely understood that the final procedure must be passed upon by the Governor, who had the advice of the scientists on the Canal Zone, before the actual work on the paintings should proceed.

The canvasses were bought "unprepared" and the artist covered them on both sides with Valspar. Ordinary tubes of artists' oil colors were used, the pigments being zinc white and permanent colors. Four of the canvasses were approximately 10 × 20 feet each and the fifth was a frieze to be placed below the four paintings. The frieze was delivered in Panama in the spring of 1914, but the building had not been completed, and the frieze was rolled on a drum 3 feet in diameter and stored in a completed part of the building. The other canvasses were delivered and placed in the spring of 1915 without going into storage. In 1928, the greatest mold growth was on the frieze. The bare walls were surfaced with Keene's Cement. The cement surface was given two coats of shellac, after which the canvasses were attached by means of a thick layer of white lead and dammar varnish. After placing, the face of the canvasses was coated with a solution of beeswax in turpentine, leaving a film of beeswax for the protective coating.

In working out a procedure for the restoration and future protection of the paintings, it was obvious that the following general procedure would have to be followed: Cleaning the surface to remove superficial dirt; removing the beeswax film without damage to the paintings; killing the mold growths by the application of fungicide; removing the dead mold, followed by another fungicide wash to insure an aseptic surface; retouching by the artist, if and where necessary; applying a protective coating containing fungicide. Taking up these items in order, the details follow.

It is well known among artists that paintings should be washed with saponin solution in preference to soap solution. This is mentioned by Laurie[1] and others.

For the removal of the beeswax film, it is well known that a satisfactory procedure is to give the surface alternate applications of turpentine and alcohol. The turpentine is the solvent and the alcohol performs a restraining action on the turpentine, minimizing possible damage to the paint film. These methods are also discussed by Laurie.[1]

The killing of the mold growths involved the selection of a fungicide. While considering the choice of a phenolic compound, our attention was

[1] "The Painter's Methods and Materials," A. P. Laurie, J. P. Lippincott Company, 1926.

called to the work of Dr. Alexander Scott,[2] Director of Research of the British Museum. He reported marked success in killing mold growths on small paintings and prints by fumigating in a closed chamber with thymol vapor. In a personal letter to Mr. Van Ingen, Dr. Scott stated that, as far as he could trace, there had been no recurrence of mildew or mold on anything they had treated, and that nothing had occurred to weaken their faith in the thymol treatment when thoroughly applied. This statement was made after experience with the fumigating treatment covering about ten years. Morris[3] carried out a comprehensive set of mold growth experiments using varying concentrations of a large number of fungicidal substances upon cultures of molds procured from many different countries. Some of the molds were more sensitive to fungicides than others, but he reported that a concentration of 0.05% of thymol completely inhibited the growth of the hardiest mold culture in his collection. His work showed thymol to have a phenol coefficient of 2.6. He also pointed out that while, in general, substances effective as germicides are also effective as fungicides, the phenol coefficients of the same substances used for the two purposes may be widely different. This is borne out in the present case by a private communication received by Mr. Herman Yagoda, the writer's assistant in this work, from Dr. Oliver Kamm, of Parke, Davis and Company, in which he states that as a general thing thymol is considered as having a phenol coefficient of 25 to 30, depending

FIGURE 1.—PHOTOGRAPH SHOWING A SMALL AREA OF THE FRIEZE BEFORE RESTORATION. THE VERTICAL CHALK LINE IS SIX INCHES LONG AND IS DIVIDED INTO INCHES

[2] "The Cleaning and Restoration of Museum Exhibits," Alexander Scott, Third Report, H. M. Stationery Office, London, 1926.

[3] *J. Textile Inst.*, **18**, T99 (1927).

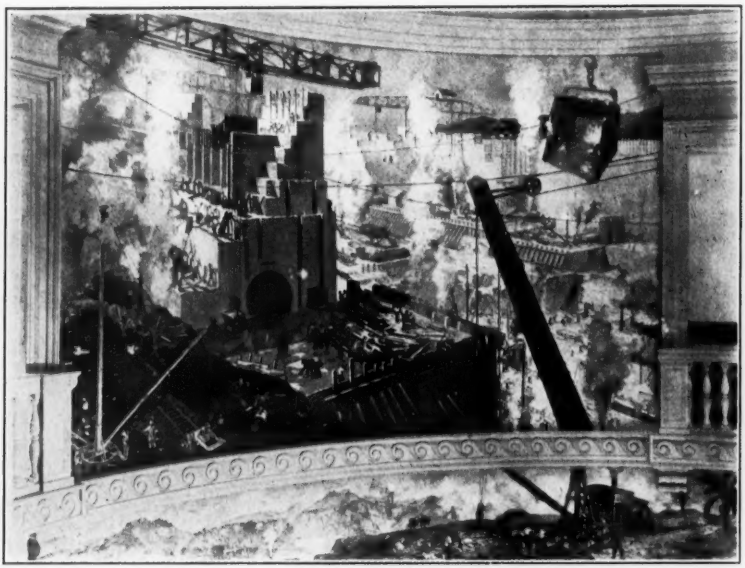
upon the individual worker and the particular method used. In order to get an idea of the vapor concentration used by Scott, several points on the vapor-pressure curve of thymol were determined in our laboratory. The points were used in plotting the vapor-pressure curve, by means of Duhring's Rule,[4] using the known curve for *o*-cresol as a standard. This work showed that thymol has a vapor pressure of only about 1 mm. in the temperature range used by Scott. All of the evidence therefore pointed to the fungicidal effectiveness of thymol in very small concentrations. Even though we did not know the identity of the mold at Panama, it was thought that we were justified in deducing that a 5% solution of thymol, a concentration 100 times as large as the minimum determined by Morris, would kill any mold. Alcohol was found to be a satisfactory solvent. For this step in the procedure, a 5% solution of thymol in alcohol was finally adopted.

FIGURE 2.—THE SAME AREA OF THE FRIEZE SHOWN IN FIGURE 1 AFTER RESTORATION

It was decided that the dead mold spots could be removed by going over them with alcoholic ammonia solution. Then, after washing again with the alcoholic thymol solution, the artist could do whatever retouching he thought necessary.

Thymol having been selected as the fungicide, it was thought desirable, as an extra precaution, to keep some of this substance permanently in contact with the paintings. A protective coating which would keep out atmospheric moisture, dirt, and mold spores, would also prevent the thymol from vaporizing and escaping. Paraffin seemed to be a suitable material, and, from the artist's standpoint, it possesses the notable property of producing

[4] "Principles of Chemical Engineering," Walker, Lewis, and McAdams, McGraw-Hill Book Company, 2nd edition, 1927.

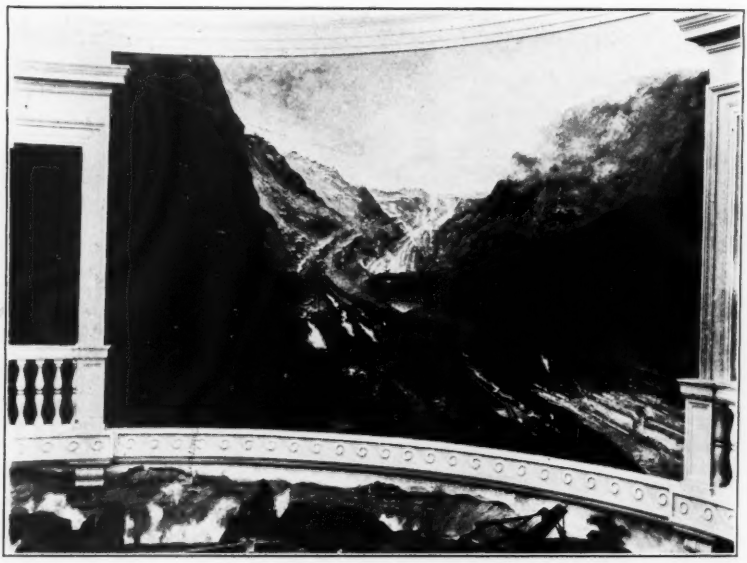


ROTUNDA DECORATIONS IN THE ADMINISTRATION BUILDING AT BALBOA: MIRAFLORES LOCKS UNDER CONSTRUCTION. A PORTION OF THE CIRCULAR FRIEZE IS VISIBLE

a dull, pleasing finish, and of being transparent and colorless when applied in thin films. Paraffin also conforms to the requirement of removability, being easily soluble in petroleum ether. If paraffin were to be selected, several questions would have to be answered. Should it be applied in molten condition or in solution in a volatile solvent? If applied in solution, would the evaporation of the solvent leave a homogeneous or a porous film? How much thymol could be added to the paraffin without too much lowering of its melting range? If the solvent method should give a homogeneous coating, then that would be the more convenient method, but should the solution be applied with a brush or with a spray gun? What solvent should be chosen and what strength of paraffin-thymol solution should be applied in order to give a coating of proper thickness? All of these questions had to be answered by laboratory experimentation. On looking up paraffin solubilities, petroleum ether seemed to be a satisfactory solvent for experimental purposes. Several glass slides were coated with molten paraffin and others with paraffin solution. The paraffin films were then examined under the microscope and no difference in homogeneity could be detected. Inasmuch as the films formed by the evaporation of solvent showed no porosity, it was immediately decided that the solvent method should be adopted. Furthermore, the slides coated by the solution

LOCK GATES UNDER ERECTION

method showed no brush marks, but those coated by the melting method resulted in thicker films and the brush marks were visible. Melting temperature experiments with paraffin containing various known percentages of thymol were carefully made, and it was found that the melting range of any given sample of paraffin was lowered 0.7°C. by adding 1% of thymol. Over a considerable range, the relationship of added thymol to melting range lowering was linear. Owing to the tropical climate, it was thought desirable to use not over 2% of added thymol, giving a lowering of only about 1.4°C. in the softening point of the paraffin. Using petroleum ether as a solvent for paraffin, atomizing experiments were made, but these all resulted in a rough surface, due to the entrainment of air bubbles and the rapid evaporation of the solvent. On the other hand, applying the solution with a brush left a smooth uniform film. Although the work would require coating about 1000 square feet, it was decided that the brush method was the only one that could be considered. Two solvents were considered, petroleum ether and benzene. Solubility determinations showed that, at room temperature, paraffin was soluble to the extent of about 19% in petroleum ether and of about 12% in benzene. Experiments on vertical surfaces showed that the rapid vaporization of petroleum ether as compared with benzene made the former more easily applied. The benzene solution had a tendency to run down the surface



CUCARACHA SLIDE AND CULEBRA CUT DURING CONSTRUCTION DAYS

before the film had an opportunity to form, while the petroleum ether vaporized almost instantly. In the course of the experimentation with petroleum ether, it was found that a solution which had been allowed to stand for several days gave, when applied to a surface, a sticky film which did not harden immediately, finally turning into a surface rougher than that made from fresh solutions. It was therefore concluded that fresh paraffin solutions should be made up each day. By weighing glass slides and cellophane strips before and after application of paraffin films, it was determined that the film thickness when deposited from an almost saturated solution was about 0.0001 inch. It was obvious that, by using nearly saturated solutions, as many coats as desired could be superimposed upon each other, as the first coat would not be dissolved in the nearly saturated solution used in applying the second coat, etc. The question as to how many coats were desirable was left for future decision after the first coat had been applied. On looking into the question of the different grades of paraffin on the market, it was decided to specify the refined product having a melting range of 56–58°C. This material has the highest melting range of the four grades readily available on the market.

Following is a summary of the procedure finally recommended. Wash the surface of the paintings with a solution of saponin in water. Remove the beeswax finish by alternate applications of turpentine and alcohol, being

careful not to damage the painted surface. Wash the surface with a 5% solution of thymol in alcohol. Remove the mold spots by applying a weak solution of ammonia in alcohol. Rewash the entire surface with the solution of thymol in alcohol. Retouch any damaged paint areas. Brush on a solution of paraffin and thymol in petroleum ether, containing 17–18% paraffin and 2% thymol based on the paraffin. Apply a second coat if it seems desirable.

When this procedure was laid before the Governor, a question was raised as to the maximum temperature of the rotunda and the possibility that the paraffin-thymol coating might soften at this temperature. In order to satisfy every one on this point, a recording thermometer was placed near the paintings and a continuous record taken for a week. Glass slides coated with the paraffin-thymol were suspended near the pictures and kept there during the same period. The maximum temperature recorded was 90°F. and no softening of the films could be detected. Then the entire procedure was adopted and authority was given for the work to proceed. After the paintings had been cleaned, it became apparent that no retouching was needed. With this exception, the work was carried out strictly in accord with the outlined procedure. An unexpected result was the freshening of the coloring of the paintings. The restoration of the paintings was completely successful. Only time will tell whether or not they have been protected against future mold attack, but it is felt that every reasonable precaution has been taken. If at some future time there should be a recurrence of mold growth, it would be an easy matter to wash off the paraffin film by the use of petroleum ether or gasoline. Then the mold could be destroyed and removed by the methods outlined above, after which a fresh coating of paraffin could be applied. All of this work could now be handled in a routine manner by skilled labor. Mr. Van Ingen holds a letter from the Governor expressing his satisfaction with the results obtained.

The writer desires to express his appreciation of the faithful and capable assistance rendered by Mr. Herman Yagoda, who carried out the experimental work in New York and who assisted Mr. Van Ingen in executing the work at Balboa Heights.

Reform of Nomenclature of Organic Chemistry. The Division of Chemistry and Chemical Technology of the National Research Council is circulating a report of the Commission of the International Union of Pure and Applied Chemistry on the Reform of the Nomenclature of Organic Chemistry and is seeking comments and criticisms of the proposed rules. It is expected that the rules will be further considered at the meeting of the Union at Liège in 1930. Any criticisms or suggestions should be sent to the chairman of the American committee, Austin M. Patterson, Xenia, Ohio.—*Ind. Eng. Chem., News Ed.*

CHEMISTRY FOR THE AMATEUR PHOTOGRAPHER. IV. FIXATION AND WASHING*

The Chemistry of Fixation

After development, the undeveloped silver bromide is removed by immersion of the negative or print in what is called the "fixing" bath. There are only a few substances which will dissolve silver bromide, and the one which is universally used in modern photography is sodium thiosulfate, $Na_2S_2O_3$, which is known to photographers as hyposulfite of soda, or more usually as hypo, though the name hyposulfite of soda is used by chemists for another substance ($Na_2S_2O_4$).

Fixing is accomplished by means of hypo only, but materials are usually transferred from the developer to the fixing bath with very little rinsing so that a good deal of developer is carried over into the fixing bath, and this soon oxidizes in the bath, turning it brown, and staining negatives or prints. In order to avoid this the bath has sodium sulfite added to it as a preservative against oxidation, and the preservative action is, of course, greater if the bath is kept in a slightly acid state. In order to prevent the gelatin from swelling and softening it is also usual to add some hardening agent to the fixing bath so that a fixing bath, instead of containing only hypo, will contain in addition sulfite, acid, and hardener.

If a few drops of acid, such as sulfuric or hydrochloric, are added to a weak solution of hypo, the hypo will be decomposed and the solution will become milky, owing to the precipitation of sulfur. This is because the acid converts the sodium thiosulfate into the free thiosulfuric acid, and this substance is quite unstable, decomposing into sulfurous acid and sulfur according to the equation:

$$\underset{\text{Thiosulfuric Acid}}{H_2S_2O_3} = \underset{\text{Sulfurous Acid}}{H_2SO_3} + \underset{\text{Sulfur}}{S}$$

The change of thiosulfate into sulfite and sulfur is reversible, since, if we boil together sulfite and sulfur we shall get thiosulfate formed, so that while acids liberate sulfur from the hypo, sulfite combines with the sulfur to form hypo again. Consequently, we can prevent acid decomposing the hypo if we have enough sulfite present, since the sulfite works in the opposite direction to the acid. An acid fixing bath, therefore, is preserved from decomposition by the sulfite, which also serves to prevent the oxidation of developer carried over into it. The developer which is carried over into the fixing bath is, however, alkaline and consequently a considerable quantity of acid is required in a fixing bath which is used for any length of time, since if only a small quantity is present, it will soon be neutralized by the developer carried over. We are, therefore, in the

* This series of articles is based upon selected chapters from "Elementary Photographic Chemistry" and "The Fundamentals of Photography," by Dr. C. E. K. Mees, published by the Eastman Kodak Company, Rochester, New York.

difficult position that we require a large quantity of acid present, and yet the fixing bath must not be strongly acid. The solution of the difficulty is found by taking advantage of the fact that there are some acids which are very weak in their acidity and yet can neutralize alkali in the same way as a strong acid, so that a large quantity of these acids can be added without making the bath so acid that sulfur is precipitated.

The strength of an acid depends upon the fact that when it is dissolved in water some of the hydrogen contained in it dissociates from the acid and remains in the solution in an active (or ionic) form, and the acidity of the solution depends upon the proportion of the hydrogen which is dissociated into the ionic form. The quantity of alkali which the acid can neutralize, however, depends upon the total quantity of the hydrogen present, and not on the dissociated portions only. The strongest acids are the mineral acids, such as sulfuric and hydrochloric, while the weakest acids are the organic acids, such as citric and acetic.

Since a large quantity of a weak acid is required, the best acid for the purpose is acetic acid (CH_3COOH).

When acetic acid cannot be obtained for the fixing bath, the only substitute which appears to be generally available is sodium bisulfite, $NaHSO_3$. This compound is intermediate between sodium sulfite and sulfurous acid, and is, therefore, equal in acidity to a mixture of equal proportions of these two substances. It makes a satisfactory acid fixing bath but does not give quite as good a reserve of available acid in the bath as acetic acid does. This is of importance particularly in connection with the hardening agent used in the fixing bath.

Potassium alum, $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$, is the commonest hardening agent. The alums in general have the property of tanning gelatin.

Fixing Baths

Acid hardening fixing baths are prepared by adding to hypo an acid hardening solution which contains the following ingredients:

(*a*) An acid such as acetic, citric, tartaric, lactic, malic, maleic, sulfuric, etc., which stops development.

(*b*) A hardening agent such as potassium alum, potassium chrome alum, or formaldehyde, 40%.

(*c*) A preservative such as sodium sulfite or sodium bisulfite. The latter acts as preservative in two ways: it prevents the formation of sulfur by the action of the acid on the hypo, while it also prevents the developer carried over into the fixing bath from oxidizing and turning brown.

Prepare the acid hardening solution as a separate stock solution and add this to the hypo solution as required.

The order of mixing is important, as follows:

When mixing in one vessel, first dissolve the sulfite in warm water (about 125°F.) (52°C.), then add the acid and then the potassium alum. It is sometimes recommended to reverse the process, namely, dissolve the alum first, add the acid, and then the sulfite, but the alum dissolves more readily in the acid-sulfite solution.

Another method is to dissolve the alum and sulfite in separate solutions, cool, add the acid to the sulfite solution and then add the alum solution.

The hypo should be cool and dissolved completely before adding the cool hardener; otherwise sulfur is likely to be precipitated.

If the order of mixing is reversed and the alum added first to the sulfite, a white sludge of aluminum sulfite is formed which dissolves with difficulty when the acid is added. Therefore, if after mixing the hardener is milky and a sludge settles out, it is due to a relative insufficiency of acid; that is, the acid used was either not up to strength or too much alum or sulfite was added.

With other hardening baths the order of mixing is usually the same.

Acid Hardening Fixing Bath for Films, Plates, and Papers

	Avoirdupois	Metric
Hypo	16 ounces	480.0 grams
Water to make	64 ounces	2.0 liters

Then add the following hardener solution slowly to the cool hypo solution while stirring the latter rapidly.

Water (about 125°F.) (52°C.)	5 ounces	160.0 cc.
Sodium sulfite	1 ounce	30.0 grams
Acetic acid (28% pure)[1]	3 ounces	96.0 cc.
Powdered potassium alum	1 ounce	30.0 grams

Dissolve in the order given.

If it is desired to mix a stock hardener solution, use:

Acid Hardener Stock Solution

	Avoirdupois	Metric
Water (about 125°F.) (52°C.)	56 ounces	1700.0 cc.
Sodium sulfite	16 ounces	480.0 grams
Acetic acid (28% pure)[1]	48 ounces	1500.0 cc.
Powdered potassium alum	16 ounces	480.0 grams
Cold water to make	1 gallon	4.0 liters

For use, add 1 part of cool stock solution slowly with stirring, to 8 parts of a 25% cool hypo solution.

To make up the hardener dissolve the chemicals in the order given above. The sodium sulfite should be dissolved completely before adding the

[1] To make 28% acetic acid from glacial acetic acid, dilute three parts of glacial acid with eight parts of water.

acetic acid. After the sulfite-acid solution has been mixed thoroughly, add the potassium alum with constant stirring. If the hypo is not thoroughly dissolved before adding the hardener a precipitate of sulfur is likely to form.

The Useful Life of Fixing Baths

A fixing bath in use becomes exhausted as a result of performing useful work in fixing out the emulsion. The acidity of the bath is being reduced by the developer carried in, although at first this tends to favor a longer "sulfurization life" or period of time before the bath precipitates sulfur. With use, however, the solution finally reaches a point where a sludge of aluminum sulfite is precipitated, rendering the bath useless. During the first stages of use, the hardening properties increase slightly, after which they fall off rapidly. A fixing bath is usually exhausted if it froths at the surface, or if it becomes milky or sludges throughout the solution. The bath may also fix so slowly that there is danger of removing the films or prints before they are completely fixed. When the time of clearing for a slow fixing film exceeds 12 to 15 minutes, the bath should be discarded.

The fixing bath for which directions have been given will fix completely the equivalent of one hundred 8″ × 10″ prints per gallon, provided a thorough water rinse precedes fixation.

Recovery of Silver from Exhausted Fixing Baths

An exhausted fixing bath contains dissolved silver salts and various methods may be employed to recover the silver profitably, providing at least 5 gallons of well-exhausted hypo are discarded each week. For large volumes of exhausted baths (about 100 gallons or more per week) precipitation with sodium sulfide is the most economical and rapid method. Precipitation with zinc dust is efficient when smaller volumes of bath are to be treated, and has the advantage that no objectionable fumes of hydrogen sulfide are evolved, as in the sulfide process.

Recovery by means of commercial electrolytic units also represents a simple and economical procedure for volumes of exhausted baths of less than 100 gallons per week. Electrolytic units give best results when used in a discarded fixing bath, rather than in a working bath.

Although it is possible for a capable chemist to so restore a fixing bath by desilvering, subsequently clarifying, and modifying its composition, that its useful life is prolonged, it is just as economical and preferable to prepare a fresh bath.

Fixing Bath Troubles

A. Sludging of the Fixing Bath: A fixing bath occasionally turns milky soon after the hardener is added, and sometimes after being in use for a short time. The milkiness may be of two kinds:

1. If the precipitate is *pale yellow* and settles very slowly on standing, it consists of sulfur and may be caused by (*a*) too much acid in the hardener; (*b*) too little sulfite or the use of impure sulfite, in which case there is not sufficient present to protect the hypo from the acid; (*c*) high temperature. The hardener should only be added to the hypo solution when at room temperature. If the temperature of the acid fixing bath is over 85°F. (29°C.), it will not remain clear longer than a few days even when mixed correctly. The only remedy is to throw the bath away and mix fresh solution as required.

If a sulfurized bath is used, the sulfur is apt to penetrate the gelatin, and later may cause fading of the image.

2. If the precipitate is *white*, and a gelatinous sludge of aluminum sulfite settles on standing, it may be caused by (*a*) too little acids in the hardener; for example, supposing a formula calls for pure glacial acetic acid and 28% acid is used by mistake, then less than one-third the required concentration of acid is present; (*b*) too little hardener in the fixing bath. When fixing prints, a relatively large proportion of the developer is carried over to the fixing bath (unless a water or acid rinse bath has been used) which soon neutralizes the acid, and therefore increases the tendency for precipitation of aluminum sulfite. In the same way a fixing bath with the correct proportion of hardener, when exhausted, still contains alum and sulfite but no acid, and these combine to form a sludge of aluminum sulfite.

B. The bath does not harden satisfactorily. Insufficient hardening may be a result of (1) the use of inferior alum which does not contain the correct proportion of aluminum sulfate; (2) the presence of too much acid or sulfite; or (3) an insufficient quantity of alum. On varying the proportions of acid, alum, and sulfite in a fixing bath, it has been found that the hardening increases as the quantity of alum increases. With increasing quantities of acetic acid, with a given quantity of alum, the hardening increases to a maximum, beyond which it decreases until the solution does not harden at all. A certain minimum quantity of acetic acid, however, is necessary to give the fixing bath a fairly long, useful life, before aluminum sulfite precipitates, but this quantity is usually greater than the quantity which produces maximum hardening. With use, therefore, the hardening ability of most fixing baths at first increases with the addition of developer to a maximum, beyond which the hardening falls off rapidly.

C. Blisters. When the sodium carbonate of the developer is neutralized by the acid in the fixing bath, carbon dioxide gas is evolved which produces blisters if the gelatin is too soft to withstand the disruptive action of the gas. If the fixing bath contains an excess of acid and the films are not rinsed sufficiently, or if a strongly acid rinse bath is used, blisters are apt to be formed. On dry film, blisters appear as tiny crater-like

depressions when examined by reflected light. This trouble is more liable to occur in hot weather, and especially when the bath is not hardening sufficiently.

D. Dichroic Fog. If the fixing bath does not contain acid or if it is old and exhausted and contains an excess of dissolved silver salts, a stain called *dichroic fog* is sometimes produced on the film. In reflected light, film stained in this way appears yellowish green and by transmitted light it looks reddish-pink. Dichroic fog never occurs in a fresh acid fixing bath, or if the film is rinsed before fixing and the temperature of the bath is kept at 65 to 70°F. (18 to 21°C.).

E. Scum on Fixing Baths. When a partially exhausted fixing bath is allowed to stand several days without use, the hydrogen sulfide gas usually present in the air reacts with the silver thiosulfate in the bath and forms a metallic appearing scum on the surface of the solution. This scum consists of silver sulfide and should be removed by drawing the edge of a sheet of blotting paper across the surface of the bath, or by using a skimmer made of several strips of cheese-cloth stretched over a wire frame.

A white scum consisting of aluminum sulfite is found sometimes on films or prints. This is caused by: (1) insufficient rinsing after development; (2) too low a concentration of acid in the fixing bath; (3) insufficient agitation of the film on first immersing in the fixing bath. Since aluminum sulfite is soluble in alkali, the scum may be removed by swabbing the film or print with a 10% solution of sodium carbonate and then washing thoroughly.

F. Mottle. When processing film or plates in hangers, a mottled image is occasionally found when the hanger has not been agitated enough on first immersing in the fixing bath, or if the film is insufficiently rinsed between development and fixation. In the absence of thorough rinsing and agitation, development continues locally during the first few minutes of fixing and in these spots the image has greater density. Mottle is also produced if the ends of the hanger protrude above the surface of the fixing bath, especially during the first stages of fixation.

The Chemistry of Washing

Washing is not usually regarded as a chemical operation. Nevertheless, the laws governing washing are distinctly chemical in their nature, and the importance of washing in photography justifies greater attention than is usually paid to the subject.

As a general rule the object in washing negatives or prints is to remove from them the chemicals of the fixing bath which they contain. In the first place, it must be pointed out that it should not be necessary to wash out silver compounds but only the chemicals of the fixing bath. If an exhausted fixing bath is used silver compounds will be present during

washing and must be removed very completely, so that if work has to be hurried and the time of washing must be cut down, it is most important that fixing should be complete.

The best way of insuring complete fixing is to use two fixing baths, and to transfer the negatives or prints to the second bath after they have been fixed in the first. Then, when the first bath begins to show signs of exhaustion and refuses to fix quickly, it should be replaced by the second, and the new, clean fixing bath should be used in the place of the second bath again.

The rate of washing depends largely upon the rate of diffusion of the hypo out of the film into the water, providing the water in contact with the film is continuously removed. This diffusion rate has nothing to do with solubility. The solubility of a substance fixes the proportion of the substance which can go into solution.

There are a number of errors which are current concerning washing. It is commonly believed, for instance, that plates and paper can be washed more rapidly in warm water than in cold. This is a mistake. It is true that any salt will diffuse more rapidly in warm water than in cold, but when washing a photographic material the diffusion has to take place in gelatin and the warmer the water in which the gelatin is placed, the more it swells, and its swelling hinders diffusion in about the same proportion as the rise in temperature accelerates it, so that, as a matter of fact, washing goes on at about the same rate at all ordinary temperatures.

It is sometimes stated that material which has been hardened in the fixing bath washes more slowly than material which has not been hardened. This, too, is incorrect. Gelatin is like a sponge; the effect of hardening it is to contract all the network of the sponge, but in so doing the gelatin as a whole is not contracted and there is no difference in the diffusion between gelatin, which has not been hardened and which has been hardened, unless the gelatin has been dried after hardening. If a negative is thoroughly hardened in the fixing bath and then is dried down, it will not expand much when soaked again and consequently diffusion through it will be difficult, but before drying the hardening does not affect diffusion and the materials which wash most quickly are those in which the gelatin has not been swollen in its treatment, either in development or fixation, but has been kept in a firm, solid condition.

The actual rate of washing may be understood by remembering that the quantity of hypo remaining in the gelatin is continually halved in the same period of time as the washing proceeds. An average negative, for instance, will give up half its hypo in fifteen seconds when washed directly under the faucet, so that at the end of fifteen seconds half the hypo will be remaining in it, after thirty seconds one-quarter, after forty-five seconds one-eighth, after one minute one-sixteenth, and so on. It will be seen that in

a short time the quantity of hypo remaining will be infinitesimal. This, however, assumes that the negative is continually exposed to fresh water, which is the most important matter in arranging the washing of either negatives or prints.

In most trays and washing tanks an average negative will give up half its hypo in 30 seconds. The process will then stop unless the water in the vessel is changed. The rate of washing thus turns out to be dependent firstly, on the degree of agitation, and secondly, on the rate of removal of the used water. This rate is dependent directly on the ratio of the stream of water falling into the vessel and the size of the vessel, quickest renewal taking place when the vessel is small and the stream large.

Only exact experimental measurements will tell when a particular vessel and stream of water will wash a specific kind of film or paper.

However, as a rough and safe working guide, the washing power of the vessel may be judged by noting the time it takes colored water to be replaced by colorless water from the faucet. To this time the minimum washing time for the material is added, and the total taken to indicate the actual period to be allowed by the photographer under his particular conditions.

A practical example will make the matter clear. Suppose that a large tray is resting in the sink and water is falling into it from the faucet and flowing to waste over the sides. Into the tray, and while the water is running, an ounce of 1% potassium permanganate solution or red ink is poured in and the time noted for the water to become completely colorless. To this time is added the minimum washing time of the material, a representative list of which is given below:

Lantern slide plates	3 minutes
Other plates	5 minutes
Film negatives, all kinds	about 7 minutes
Single weight Velox	15 to 20 minutes
Single weight Bromide	20 to 25 minutes
Double weight Bromide	35 to 60 minutes

If it be found that the water in the tray takes 10 minutes to clear, then the time for a lantern plate to become throughly washed would be 13 minutes and for Velox about 25 minutes. If the water supply were doubled and the rate of color discharge shortened to 5 minutes the washing times would be 8 minutes and 20 minutes, respectively. Finally, if the lantern plate were held under an open faucet in the hand, the renewal of water at the emulsion surface would be extremely rapid and the plate would be *safely washed in 3 minutes*. The moral is to use plenty of water and plenty of agitation.

If a lot of prints are put in a tray and water allowed to splash on the top of the prints, it is very easy for the water on the top to run off again, and

for the prints at the bottom to lie soaking in a pool of fairly strong hypo solution, which is much heavier than water and which will fall to the bottom of the tray. If the quickest washing is desired, washing tanks should be arranged so that the water is changed continuously and completely and the prints or negatives are subjected to a continuous current of fresh water. If water is of value, and it is desired to economize in its use, then by far the most effective way of washing is to use successive changes of small volumes of water, putting the prints first in one tray for two to five minutes, and then transferring them to an entirely fresh lot of water, and repeating this procedure about six times.

Now a word of warning about contaminating partly washed photographs. If the hypo comes out to half its previous strength in a fraction of a minute, so also will the reverse change occur. If a partly washed print is touched by fingers contaminated with the fixing bath, in a few seconds the hypo will be shared between the fingers and the photograph, and it will take the full washing time to remove it again.

Since hypo is invisible and its evil effects are not detected till long afterward, prints or films fresh from the hypo should never be placed among those partly washed. If this is done the entire batch must be washed from the time that the last one was added.

The best way to avoid contamination is to wash in *cascade*. In its simplest form this can be accomplished by placing two trays side by side, one an inch or so above the level of the other. Water is allowed to run into the upper tray and overflow into the lower. All prints and films should be placed in the lower tray before transference to the upper. The operator should also use the lower tray for washing hypo off his fingers. The prints and films should have at least three minutes preliminary washing before going into the true washing tray. With a little experience in handling materials in this serial order the photographer will be surprised at the number of films and papers that can be passed through quite moderate capacity trays and completely satisfactory washing secured in a short time.

The progress of washing can be followed by removing two or three prints at intervals from the bath and testing for hypo by tasting the prints since hypo containing silver has a sweet taste.

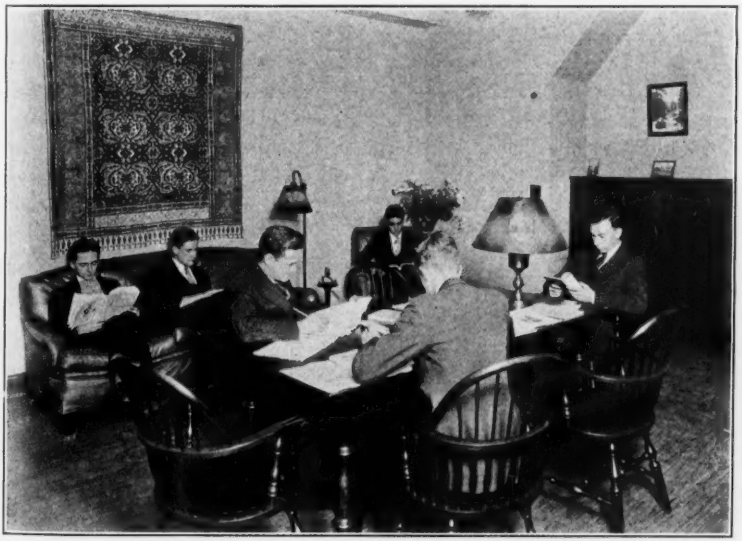
Six changes of water, allowing five minutes for each change, should be sufficient to eliminate the hypo effectively from any ordinary photographic material.

New Science of Flow Christened Rheology. Add *rheology* to your vocabulary. It is the name of a new branch of science, the science of flow. Chemists and physicists interested in why and how paints, lacquers, oils, and other plastic substances deform and flow gathered recently at the U. S. Bureau of Standards and christened the new science by organizing the Society of Rheology.—*Science Service*

A MODEL CHEMISTRY CLUBROOM

NORRIS W. RAKESTRAW, BROWN UNIVERSITY, PROVIDENCE, RHODE ISLAND

Any one who is familiar with the usual type of "student clubroom" will have a pleasant surprise on entering the new home of the Chemistry Club of Brown University. No straight-backed chairs, wire wastebaskets, blackboards, or pencil-marked walls are to be found here. Instead, one can almost imagine, as he steps from the lower hall of Metcalf Laboratory into the inviting atmosphere of this room, that he has left chemistry a thousand miles behind him. Almost, but not quite, for among the many magazines on the reading table he will find some, at least, which are chemi-



A CORNER OF THE CHEMISTRY CLUBROOM AT BROWN UNIVERSITY

cal, although he will have no occasion to suspect that he has wandered into the departmental library by mistake. Furthermore, the parchment shades on the floor lamps beside the davenport and on the large table lamp, designed by one of the graduate students, will remind him by their chemical symbolism that he is still among chemists.

The room is beautifully furnished in leather and Tudor mahogany, and everything possible has been done to create an atmosphere of comfort and relaxation, even to the installation of a radio-victrola, not shown in the accompanying photograph, which is the crowning touch. The walls have been tastefully decorated and the windows appropriately draped, for which the students themselves have been responsible. A small reading library

is rapidly accumulating, consisting of books and periodicals both scientific and otherwise, due to the generosity of friends and members of the department staff. This small collection is in no way a duplication or competitor of the regular departmental library, but rather an invitation to mental activity during leisure periods.

The opening of this clubroom in Metcalf Laboratory is the fulfilment of a need long recognized. The major students in the chemistry department at Brown have been increasing in number during the last few years and becoming more and more intimately associated as a unified group. The Chemistry Club, composed of both graduates and undergraduates, has long felt the need of a suitable center for its constructive activities. At the same time a softening influence in the tense strain of graduate work became of the utmost importance. At just the right moment the "Visiting Committee" of the department, a semi-official group of friends and advisers, stepped forward with an offer of help. The Chemistry Clubroom, which they have designed and furnished, has probably no equal in any institution in the country.

The care and maintenance of the room, and all regulations concerning its use, have been left in the hands of the student members of the Club, with only nominal supervision by the departmental staff. Although the room is ordinarily kept locked, the members of the Club, which includes all major students beyond the first year, are entitled to keys.

The room gets its greatest use, of course, in the evenings, when some one is almost always to be found there, and especially after the monthly meetings of the Club, the regular graduate research seminars, or the occasional special lectures or meetings in the laboratory.

Established in the hope of strengthening the morale of the department and furthering the spirit of comradeship and coöperation among its student body, the clubroom has thus far fulfilled its purpose admirably. The fear that it might prove a distraction is entirely dissipated. The University is proud of its recent acquisition and happy to be able to display it as a model to others.

Finds Engines Run Better Using Ethylene Glycol Instead of Water for Cooling. Automobile and airplane engines run most efficiently at a temperature which would instantly boil away their cooling water, Gerhardt W. Frank, air corps engineer at Wright Field, Dayton, Ohio, has found.

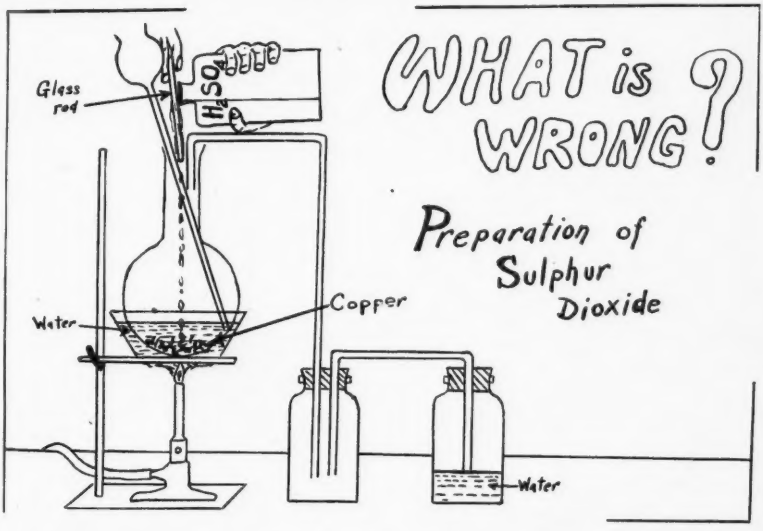
Using ethylene glycol as the cooling liquid, Mr. Frank found that a temperature of 250 degrees Fahrenheit was reached in a full throttle test on an airplane engine. Water, commonly used as the cooling agent, would have boiled away at 212 degrees. Ethylene glycol, which is sold as an auto anti-freeze solution, boils at 387 degrees.

A power loss of three per cent caused by the high temperature was more than compensated for by a better fuel economy and reduction of radiator size, cooling liquid required, engine weight and wind resistance.—*Science Service*

CONTEST FOR HIGH-SCHOOL AND FRESHMAN STUDENTS

On this page is reproduced another of the series of drawings prepared for us by Prof. John J. Condon of William Nottingham High School, Syracuse, New York. Write a brief statement, telling what is wrong with the picture. Use complete sentences; do not merely list mistakes. Type your manuscript, if possible; if not, be sure that you write legibly. Type or write on one side of the paper only.

Make a correct drawing, showing the picture as you think it should be. Use black India ink and white drawing paper. (If you believe that you can draw better on coördinate paper, white paper with blue rulings must be used.) Drawings should be approximately 4″ × 6″ or 8″ × 12″.



Place your name at the top of each page of your manuscript and at the top of your drawing.

On a separate sheet accompanying your manuscript write your own name, the name and address of the institution at which you are a student, the name of your chemistry instructor, and the name of the chemistry club at your institution (if there is one).

Address your paper to: The Associate Editor, JOURNAL OF CHEMICAL EDUCATION, The Johns Hopkins University, Homewood, Baltimore, Md.

Your contribution to this month's contest must be postmarked not later than April 15th.

Awards

The best contribution received will be awarded a prize of five dollars and will be published in the June JOURNAL. The five next best papers will

receive awards of one dollar each and the names of the winners will be printed in the June number.

Contributions will be judged on the basis of:

1. Correctness from a chemical standpoint
2. Neatness and correctness of drawing
3. English
4. Neatness and legibility of manuscript.

Papers which do not comply with all of the rules of the contest will not be considered.

WHAT IS SCIENCE?

Science is nothing but trained and organized common sense.—HUXLEY

Science is nothing more or less than the most accurate and best authenticated information that exists, subject to constant rectification and amplification, of man and his world.—ROBINSON

The scientist is a questioner, a discoverer, a pointer-out.—ROBINSON

Science is an orderly or systematic arrangement of statements of fact or truth; that is scientific in which all the statements are accurate and their correct relation to each is set forth in logical order.—CRANE

Science embraces the whole immense round of truth.—CRANE

Science is an intellectual outlook, a standard of truth, and a gospel of light.—GREGORY

The first object of a course in science should be to develop a scientific habit of thought.—REMSEN

The object of science is to codify knowledge and to describe relations between phenomena in the simplest possible terms.—EAST

Science is thoughtful inquiry into the order of nature, human nature included.—CURTIS

Science is the product of human reason applied to the phenomena of nature. The straight-thinking man was always a scientist.—CURTIS

Scientists are not wizards, but men who apply to natural phenomena the methods of analysis used by logical minds in the affairs of daily life.—CURTIS

Science, in short, includes all the careful and critical knowledge we have about anything of which we can come to know something.—ROBINSON

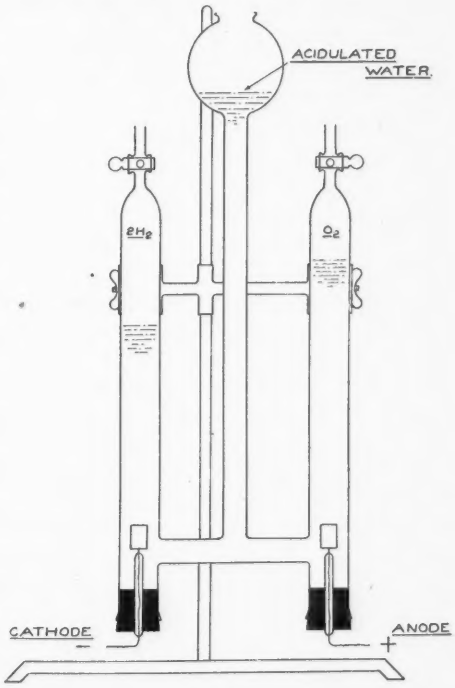
Science Educ.

Science is the systematic description of natural phenomena.—THEODORE W. RICHARDS

What is the aim of science? Not only to *know* but much more to understand nature, and we *understand* a phenomenon only when we recognize logic in it. So in science we try to discover logic in the behavior of matter. We meet every moment with phenomena which at first sight seem contradictory; then we try to reconcile them, *i. e.*, to raise the problem to a higher level where the apparent contradiction dissolves to a higher unity. We cannot be content as long as we have not found this unity, and therefore we are continually pursuing that goal.—H. R. KRUYT

WINNERS IN FIFTH "WHAT IS WRONG?" CONTEST

To speak frankly we were disappointed in the caliber of the entries submitted in the fifth contest.[1] Every contribution without exception left something to be desired and many of the accompanying drawings were poorly drafted, or incorrect, or both. After much tearful consideration we have selected the contribution of Robert C. Schmitz, of Milwaukee, Wisconsin, as suffering from the least of many evils, even though he did not elect to correct the entire picture in his drawing. We shall not, however, quote his criticism in full.



To dissolve sodium chloride quickly, the salt should be placed directly in the water and stirred. The test tube with a small hole in it, that was shown suspended in the water, prevents the salt from dissolving rapidly. . . .

The Hoffmann electrolytic apparatus, as was shown in the drawing, was insufficiently supported. The apparatus should be held by a clamp on each of the two collecting chambers, instead of one clamp on the reservoir tube. If supported with one clamp, as is shown in the drawing, a slight jolt would break the tube, and also if one should draw off some of the gas that is being liberated, and the stopcock offered a little resistance, the tube might be broken.

The drawing did not show the small passageways in the cores of the stopcocks, but it did show the handles of the cocks parallel with the tubes; for these reasons one concludes that the cocks are open, thereby permitting the gases to escape into the atmosphere.

The clamp of the stand, as was shown in the drawing, blocked the passageway of the water in the reservoir tube, the mouth of this tube was also shown closed. The arm of the clamp was drawn through the collecting chamber containing oxygen, and it likewise had shown the passageways of the gases closed, thus preventing either of the gases from being drawn off.

The wires leading to the platinum electrodes, as were shown in the drawing, had no protective glass insulation to give them a rigid support or to keep them from being bent. . . . .

[1] See THIS JOURNAL, **7**, 436–7 (Feb., 1930).

Bubbles are often filled with hydrogen to show the density of this gas in comparison to that of air. The bubble will rise rapidly, because the gas is approximately one fourteenth as heavy as air. Bubbles containing carbon dioxide will descend, for this gas is about one and one half times heavier than air. The three bubbles containing carbon dioxide, as were shown in the drawing, would not remain suspended within a beaker filled with air, for the gas is heavier than air, as stated above. . . . .

The SO_2 indicated in the original diagram is, of course unnecessary. There is the further objection that it would contaminate the products of electrolysis.

Many contestants seemed to have a mistaken notion as to the voltage necessary to decompose water. As a matter of fact water can be decomposed with an e. m. f. of 1.67 volts, at which current tension both oxidions and hydroxidions will be discharged. For practical purposes a voltage of 2 to 3 or more is used, for sulfanion (at 1.93 volts) and hydrosulfanion (at 2.63 volts) are then both discharged. From a theoretical standpoint a voltage above three is entirely unnecessary.[2]

One contestant made us a present of the surprising information that the oxygen molecule contains but one atom. If, on second thought, he is still of the same opinion, we refer him to p. 674 of the March number of THIS JOURNAL where he will find a detailed proof that such is not the case.

We were somewhat surprised that no one mentioned the effect of temperature on the solubility and rate of solution of NaCl. Actually, the temperature gradient is so slight in the case of this particular salt that there is no practical advantage in heating, but we had expected some one to mention that fact.

Soap bubbles should, of course, be spherical.

Those who submitted the remaining five least-worst papers were as follows: Charles W. Gibson, Warransburg, Missouri; Mabel Miller, Bluffton, Ohio; Elmer Drumm, Fisher's Ferry, Pennsylvania; Paul Butera, Cleveland, Ohio; Angela Barrios, El Paso, Texas.

[2] See Walker's "Introduction to Physical Chemistry," Macmillan, **1922,** p. 369.

Flowers and Fruits Possible under Artificial Light. Flowers, fruits, and vegetables raised by artificial light only in underground hothouses are quite within the realm of possibility, so long as there is a plentiful supply of cheap electricity. So said Samuel G. Hibben, lighting specialist of the Westinghouse Lamp Company, in a report to the Illuminating Engineering Society.

Natural sunlight is not necessary for the normal development of plant life, he said. Artificial light has been used with success in the experimental growing of plants in laboratories, and it is being used now as a regular commercial proposition in the speeding up of the maturing of vegetables grown under glass and the blossoming of cut flowers.—*Science Service*

THE LIBRARY

POPULAR SCIENCE MONTHLY, *March, 1930*

(*P. 24.*) "Threads That Swing 350,000 Tons." *Frederick Tisdale.* Steel wires are "spun" into cables capable of carrying tremendous loads. Cable railways, suspension bridges, mine cables are examples. The author deals almost entirely with the physical and engineering aspects of the subject. (*Illustrated.*)

(*P. 30.*) "New Safety Glass Resists Fire and Bullets." A new safety glass developed by an English firm is said to be proof against fire, splintering, and discoloration. "Xetal," the new product, resembles ordinary glass but withstands breakage by a service revolver bullet at short range.

(*P. 30.*) "Rare Metal in Quantity." Dr. H. M. Partridge of New York University has developed a process for quantity production of lithium which reduces the cost from $240 to $15 per pound. The nature of the process is not stated. Present uses of lithium are chiefly in bell-metal alloys and in the purification of helium. New uses will no doubt be developed now that the cost has been so greatly reduced.

(*P. 32.*) "Welded Steel Floors for Higher Skyscrapers." One of the factors limiting the height of skyscrapers has been the enormous dead weight of flooring. A new idea in design is to make the floor act as a solid steel girder, strengthening the entire frame against torsional stresses. The application of this idea is made possible by the invention of an automatic arc-welding machine which "sews" steel floor plates together, uniting them into a one-piece sheet of solid steel.

(*P. 35.*) "The Car Makes Its Own Gas." A photograph with descriptive caption, showing a cylindrical attachment for an automobile engine. The cylinder is in effect a portable still which "cracks" crude oil to furnish the gasoline on which the car runs.

(*P. 37.*) "Fuel Oil Carburetor." Photograph with descriptive caption. A special carburetor designed to permit automobiles to operate on fuel oil.

(*P. 37.*) "Fighting Fires with Streams of Powder." Two photographs with descriptive caption. A new German fire engine projects streams of powder instead of liquid. The nature of the powder is not described otherwise than by saying that it is a "harmless carbonic acid powder."

(*P. 37.*) "Featherweight Office Furniture." Photograph showing a girl supporting a six-pound aluminum office chair on one finger.

(*P. 38.*) "Household Ice Boxes May Go 'Dry,' Too." Walter S. Johnson, one of the pioneers in the development of "dry ice," recently prophesied that solid carbon dioxide will eventually replace water ice for household refrigerators. He says that a 75-pound block of "dry ice" will maintain the ordinary household refrigerator at proper temperature for a week.

(*P. 38.*) "Burnt Toast Packed with Invisible Diamonds?" Various forms of carbon, such as graphite, diamond, etc., have different magnetic

properties. An Indian physicist has found that the carbon of a smoky flame, carbonized sugar, etc., has properties like the diamond.

(*P. 38.*) "Alcohol from Watermelons." A newly established Russian factory will manufacture alcoholic sirups from watermelon pulp. The better grades will be used in cooking, confectionery, etc.; the poorer will be converted into industrial alcohol.

(*P. 39.*) "From Wood Pulp to Rayon Silk." A series of twenty sketches, showing various operations in the manufacture of rayon thread.

(*P. 42.*) "The Men Who Will Award Our $10,000 Prize." Biographical paragraphs and photographs of the twenty-two scientists, inventors, and engineers who will act as a committee of award in selecting the winner of the annual *Popular Science Monthly* prize. [See first item, **The Library,** THIS JOURNAL, **7,** 668 (March, 1930).]

(*P. 45.*) "Panning for Gold—The Old and New Ways." Photographs showing the old-time hand-panning method and the modern electric dredge. A descriptive paragraph accompanies the pictures.

(*P. 45.*) "Huge X-Ray Tubes Produce Man-Made Radium Rays." A battery of X-ray tubes immersed in oil is operated at a voltage of 1,600,000. Generating apparatus capable of supplying 5,000,000 volts has been constructed but tubes to operate at this "pressure" have not yet been constructed.

(*P. 45.*) "Dynamite Blast Travels Four Miles a Second." By means of a cleverly devised instrument the Bureau of Mines has measured the speed of an explosion wave along a dynamite cartridge. This is one of the fastest chemical reactions known.

(*P. 45.*) "Excess Humidity Reduces Power." The Bureau of Standards finds that gasoline engines develop less power when the humidity of the atmosphere is high.

(*P. 46.*) "New Gas Treatment Ripens Fruit in a Few Hours." Another note on the effects of ethylene. (*Photograph.*)

(*P. 48.*) "Foresees Electric Heat from 'Coke Batteries.'" If practical batteries could be devised to consume coke and air and furnish electrical energy, coal could be much more efficiently utilized, both for heat and power, than it is at present by burning.

(*P. 50.*) "Automatic Chemist Saves Work in Laboratory." An automatic titration device makes use of a photoelectric cell. When the color change of the indicator causes a variation in the intensity of a beam of light directed through the solution which is being titrated, a bell is rung and the titration reagent is shut off. (*Photograph.*)

(*P. 50.*) "Poor Food, Not High Life, the Cause of Ills." Dr. Lovell Langstroth believes that arthritis, some forms of heart disease, high blood pressure, chronic stomach trouble, result from too high a proportion of

non-protective foods in the diet. "Protective" foods are those which are high in mineral and vitamin content.

(*P. 51.*) "Diamonds from Sugar." Photograph with descriptive caption. Prof. J. M. Hershey of McPherson College, Kansas, claims to have produced diamonds the size of a grain of sand by subjecting ordinary table sugar to enormous heat and pressure.

(*P. 54.*) "Next—Beryllium Planes?" Beryllium is exceptionally hard and strong as well as very light. If the present prohibitive cost of $200 per pound could be reduced sufficiently by the development of suitable extraction methods, this metal would play an important part in aircraft construction.

(*P. 61.*) "Mystery in New Blue Gem." Zircons, hitherto known only in brown, greenish, or yellow colors are now appearing in beautiful deep blues. The blue coloration is the result of an artificial treatment of the natural stone, but only certain stones are capable of assuming the blue color under treatment. Dr. George F. Kunz believes that this ability to change color is due to traces of the element hafnium which are present in some zircons but not in all.

(*P. 66.*) "Ice Crystals Ages Old." The largest perfect water crystals ever known have been found in a cave in southwestern France. Some were about four inches long and an inch thick. The formation of these unusual crystals is believed due to the very constant temperature and humidity conditions of the cave.

(*P. 66.*) "Aluminum Playing Cards." The metal cards look and feel like ordinary cards but are a little heavier. They are recommended for camp or other outdoor use. When soiled they can be washed.

(*P. 112.*) "Home Workshop Chemistry." Directions for the construction of two home-made electrical cells and for the preparation of glutin glue.

(*P. 146.*) "Helium Plant on Wheels." A portable helium reclaiming plant which can be towed behind a motor truck has been devised and built for the Navy.

THE SCIENTIFIC AMERICAN, *March, 1930*

(*P. 202.*) "The Romance of Steel." *Martin Meyer.* The author introduces his subject with a paragraph on the prehistoric discovery of iron smelting. He immediately proceeds to the transition from the Iron to the Steel Age, which took place less than a century ago. Several paragraphs are devoted to outlining some of the widely varying properties attainable in steels of different compositions and of the uses to which such steels may be put. The remainder of the article treats chiefly of the principles and processes of steel-making. Finally, there is a brief discussion of the economic significance of steel and of the part played by coal and iron deposits in international politics. (The editor states that

this article is one of a series on the romance of chemistry. The extent of the series will depend upon the number and nature of comments received from readers.) (*Illustrated.*)

(*P. 212.*) "What's in the Sun?" *Henry Norris Russell.* The author explains the theory of spectroscopic analysis in simple terms. He tells how it is possible to calculate the amounts of various elements present in the sun and gives the results of some calculations of this kind. (*Illustrated.*)

(*P. 220.*) "Refining Metals by Electrolysis." *Henry W. Hough.* The article deals chiefly with the zinc extraction and electrolytic refining plants of the Anaconda Copper Company. One paragraph is devoted to copper refining. (*Illustrated.*)

(*P. 223.*) "Diet Causes Fatigue." Fatigue, diet, and the working capacity of the modern business girl are closely related, and decrease in working capacity due to fatigue can be offset by the timely ingestion of highly concentrated energizing foods, according to the results of tests conducted by Dr. Thaddeus L. Bolton of Temple University, Philadelphia. Unwise reducing diets increase time lost due to illness and decrease the volume and lower the quality of work done in the office.

(*P. 226.*) "The Plant's Whimsical Appetite." *Earl S. Johnston.* The author describes certain deficiencies in plant growth arising from the absence of minute quantities of certain elements from the nutrient medium. Boron is stressed. The information is practically the same as that presented in THIS JOURNAL, **5**, 1235–42 (Oct., 1928). "Boron: Its Importance in Plant Growth." (*Illustrated.*)

(*P. 228.*) " 'Tempered' Copper." Contrary to popular impression, the hardening of copper is not a lost art. We can produce the hard copper alloys which the ancients knew and more and better ones beside. We can also harden copper alloys by heat treating, which the ancients did not know how to do. The compositions and properties of a number of specific alloys are described.

(*P. 229.*) "New Wrought Iron Process Eliminates 'Puddler.' " No details are given.

(*P. 230.*) "Chemical Kills Weeds but Lets Little Trees Live." It has been found that zinc sulfate dissolved in water and sprinkled over the ground at the rate of about 8 grams per square foot kills practically all weeds but does not seriously reduce germination of conifer seeds or growth of conifer seedlings in nursery beds.

(*P. 231.*) "Welded Steel Flooring for Tall Buildings." A somewhat more detailed account than that abstracted on p. 897. (*Photograph.*)

(*P. 236, et seq.*) "Chemistry in Industry." Includes the following items: "New Process Enables Metal Coating to Be Sprayed on Anything." A newly invented pistol, which makes use of an oxyacetylene flame, atomizes molten metal and sprays it against the surface to be coated.

The surface must be roughened and free from oil and grease. There is little heat effect at the coated surface—paper, cloth, and even celluloid may be so treated. The applied film, about 0.001 inch or more in thickness, is very adherent and does not break under bending. It has a pleasing matte finish and can be buffed if a polish is desired. "Chemists Pre-Determine Relative Corrosiveness of Soils." Soil analyses furnish the basis for calculation of corrosiveness of soils in which pipe lines are to be laid and indicate the protection necessary to guard against corrosion. (*Illustrated.*) "Electrical Eye Detects Smoke." Another use for the photoelectric cell. Ventilation of vehicular tunnels can be controlled in accordance with the amount of smoke in the atmosphere. (*Photograph.*) "Coats Aluminum with Lime as Base for Paint." Aluminum articles, when boiled with milk of lime containing a little calcium sulfate, are given a fine-grained, closely adherent, dead-white coating which may prove to be an excellent foundation for the application of paints or enamels. The coating probably cannot be recommended for corrosion resistance, but it gives a surface that can be written on. "Edible Oil from Nut Shells." Pecan oil is extracted from nut fragments which accumulate at shelling plants. "Fuel Gas from Farm Waste." Experiments at the University of Illinois indicate that it may be possible for farmers to generate gas for heating and other purposes from cornstalks and sewage by fermentation processes.

SCIENCE AND INVENTION, *March, 1930*

(*P. 989.*) "In the Spotlight of Science." A series of photographs with explanatory captions. One item shows Dr. P. H. Carr of Cornell University with his apparatus for making photographic impressions of electron streams on metal surfaces.

(*P. 1018.*) "450 Miles to the Gallon!" *Alfred M. Caddell.* Gasoline contains more potential energy than T. N. T. or nitroglycerin. Only about 5 per cent of this energy does useful work in driving the ordinary automobile. One hundred per cent conversion of potential energy into useful work would enable a gallon of gasoline to drive a Ford about 450 miles. (Obviously any such ideal conversion is far beyond the bounds of practical possibility.) The author indicates a number of points of attack through which engineers hope to raise our present 5 per cent efficiency to 8 or 10 per cent or even somewhat higher. Knock prevention and proper carburetion are discussed. (*One diagram, several cartoons.*)

(*P. 100.*) "Continuous Distillation." A continuously operating water still which can be constructed from ordinary laboratory glassware. (*Diagram.*)

POPULAR MECHANICS, *March, 1930*

(*P. 363.*) "Glass Substitute Is Flexible and Does Not Splinter." An organic substance called "vitreo-colloid," manufactured by a British com-

pany, may prove a suitable substitute for glass in automobile windows. It is flexible like celluloid, but non-inflammable; is hard enough not to scratch easily, but can be cut, drilled, or molded and is an excellent insulator.

(*P. 362.*) "Substitute for Metal Cans and Glass Containers." A cellulose product having the strength of metal and the transparency of glass is being tested as a possible substitute for metal cans and glass containers for preserving foodstuffs.

(*P. 363.*) "Lead Alloy More Efficient than Pure Metal." Tests to determine the cause of breakdowns in lead cable sheathings have led to the discovery that an alloy consisting of 98.25 per cent lead, 1.50 per cent tin, and 0.25 per cent cadmium is stronger, lighter, and more resistant to vibration and corrosion than pure lead.

(*P. 364.*) "Chemical Muffler Removes Carbon Monoxide." A catalyst has been devised which completely oxidizes automobile exhaust gases, including CO, unburned fuel, and smoke.

(*P. 365.*) "Sugar Produced by Germs Offer Disease Cure?" A sugar produced by tuberculosis germs has been found to serve as a bond between the germ and the cell on which it feeds. This discovery may point the way toward means of combating the disease.

(*P. 377.*) "Sea Water Used to Irrigate by Crystallizing Salt." A Los Angeles agronomist claims to have devised a method whereby common salt may be crystallized from sea water by means of high-frequency currents, cathode rays, etc. Salts having fertilizing value are not removed and the treated water is used for irrigation. (*Photograph.*)

(*P. 383.*) "Gears Made from Cornstalks Give Long Wear." Seven gear wheels manufactured from cornstalks have been in service at the Iowa State College for over two years and show practically no signs of wear. A substitute for teakwood about sixty per cent stronger than the natural wood has been developed. A substitute for tile has also been perfected. A material lighter than balsa wood is being prepared from cornstalk pith, and a substitute for cork has been developed.

(*P. 400.*) "Fire and Water from One Pipe of Well." A well recently drilled by a company searching for coal brought forth a stream of water so cold that it could be used for refrigerating purposes. A camper who held a light near the outlet was amazed to see the stream of water apparently burst into flame. The explanation offered is that the well tapped a pocket of gas under pressure. The gas, expanding, cooled the water. Some gas escaping from the pipe with the water could be ignited.

(*P. 402.*) "Man-Made Mystery Metals." *John Draper.* The United States Bureau of Mines has established a special laboratory at Reno, Nevada, for the purpose of studying alloys and their properties. The author cites some of the wonders of modern civilization which have been

made possible by alloys. He discusses a number of specific alloys, their properties, and uses. (*Illustrated.*)

(*P. 407.*) "Fireproof Walls of Straw for Building Material." Non-inflammable walls of compressed and fireproofed straw were recently exhibited in Berlin. They are particularly recommended for weather-proofing houses. (*Photograph.*)

(*P. 432.*) "Fuel Oil from Nuts." Oil of the babassu tree, a little-known member of the cocopalm family, besides comparing favorably with other edible vegetable oils, has a high fuel value.

(*P. 433.*) "Photograph on Metal Plate in Broad Daylight." A method for developing impressions made on plates of metal by streams of electrons has recently been devised. (*Photograph.*)

(*P. 448.*) "Solidified Liquid Is Hard and Flexible as Paper." Discovery of a chemical composition combining hardness and flexibility in a remarkable degree has been announced by Dr. Hal T. Beans of Columbia University. "Durium" is the name of the composition, described as a liquid in its original form, which is transformed by heat into an insoluble, infusible solid. A number of possible uses for the new composition are mentioned. Durium will find its first practical application in the making of phonograph records. The records are as light as cardboard, flexible and, at the same time, cheaper and more durable than ordinary records.

(*P. 454.*) "Robot Has an Electric Eye and Radio-Brain." An automatic titration device employing a photoelectric cell.

(*P. 465.*) "Blue Gem Colored by Heating." Essentially the same information contained in abstract on zircon (p. 899 of THIS JOURNAL).

Study Vital Organs with X-Ray Movies. A normal human lung rids itself of foreign material by means of a peculiar rhythmic motion of the bronchial tubes, Dr. H. A. Jarre of Detroit told members of the Radiological Society of North America at their recent meeting at Toronto. This discovery was made with the aid of a new X-ray motion picture camera.

"The pictures we take are slow motion because the organic movement in the body will only tolerate a limited amount of X-ray energy," said Dr. Jarre in explaining the new machine, which is to be called the Cin-Ex Camera. The pictures are taken at the rate of one to four seconds, while the regular picture camera takes sixteen exposures per second.

The bodily organs which have been studied most intensively with the new camera are the bronchial tubes, kidneys, heart, and large blood vessels, thymus gland, and stomach and intestines. An interesting cyclic motion of the kidneys was observed. Dr. Jarre reported that he and his associates discovered a peculiar rhythmic motion phenomenon of the bronchial tubes during breathing "so that in a normal human lung foreign materials and excretions as well as air are expelled by these movements alone."—*Science Service*

THE ATLANTA MEETING* OF THE A. C. S., APRIL 7TH TO 11TH

Program of the Division of Chemical Education

J. N. SWAN, *Chairman*
R. A. BAKER, *Secretary*
M. A. GAERTNER, *Local Secretary*

MONDAY, APRIL 7TH

8.00 A.M. Breakfast Meeting, Executive Committee. Dining Room, Biltmore Hotel.

TUESDAY, APRIL 8TH

1. 2.00 P.M. J. N. SWAN. *Chairman's Address:* "Laboratory Work, Past and Present."
2. 2.10 P.M. G. ALBERT HILL. "Laboratory Equipment and Laboratory Instruction."
3. 2.30 P.M. STUART R. BRINKLEY. "Objectives of the Courses in General Chemistry."
4. 2.50 P.M. C. A. BRAUTLECHT. "Why Teach Chemistry?"
5. 3.00 P.M. R. T. STONE. "An Experiment in the Teaching of General Chemistry in College."
6. 3.15 P.M. H. A. WEBB. "The Mathematical Foundation for General Inorganic Chemistry."

3.25 P.M. *Recess.*

7. 3.30 P.M. JOHN W. BARKER. "A Research System in the General Chemistry Laboratory."
8. 3.45 P.M. JACK P. MONTGOMERY. "Does the College Teacher in General Chemistry Need Training in Education?"
9. 3.55 P.M. ROBERT COLLIER, JR. "Increasing Interest in High-School Chemistry."
10. 4.05 P.M. JOHN R. SAMPEY. "The Teaching of First-Year Organic Chemistry."
11. 4.20 P.M. C. C. SPENCER. "Student Performance in Advanced Chemistry Courses."
12. 4.30 P.M. EARL W. PHELAN. "Salaries, Experience and Training of Chemistry Teachers in Ohio High Schools."
13. 4.45 P.M. CLYDE W. MASON. "The Reclassification of a Chemistry Library According to the Library of Congress System."

WEDNESDAY, APRIL 9TH

8.30 A.M. *Meeting of Senate of Chemical Education.* First Baptist Church. (A breakfast for the Senate will

* The preliminary program of the Atlanta Meeting appeared in the January 20th *News Edition* of *Industrial and Engineering Chemistry.* The final program will appear in the March 20th number of the same publication.

be served in Room 2, on the Mezzanine of the Biltmore at 7.30.)

14. 10.15 A.M. LEON V. QUIGLEY. "Educational Coöperation by Industry."

15. 10.35 A.M. J. F. SELLERS. "Fifty Years Progress in Chemistry Teaching in Southern Colleges."

16. 11.15 A.M. J. E. MILLS. "Some Matters Which Concern the Progress of Chemical Education in the South."

12.15 P.M. *Luncheon* ($1.00) Division of Chemical Education, Georgian Terrace (Complimentary to High-School Chemistry Teachers).

2.00 P.M. *Joint meeting with the Cellulose Division.* Symposium on "The Relation of Cotton to Chemistry." CHARLES H. HERTY, presiding.

17. 2.00 P.M. CHARLES H. HERTY. Introduction.

18. 2.10 P.M. HARRY LEB. GRAY. "The Constitution and Properties of Cellulose."

19. 2.45 P.M. CHARLES E. MULLIN. "The Relation of Cotton to Synthetic Fibers."

3.20 P.M. *Recess.*

20. 3.25 P.M. DAVID WESSON. "The Cotton Crop and Our Food Supply."

21. 4.00 P.M. M. J. CALLAHAN. "The Relation of Cotton to Lacquer."

22. 4.35 P.M. R. G. WOODBRIDGE. "The Relation of Cotton to Explosives."

5.00 P.M. *Meeting of Editors of the* JOURNAL OF CHEMICAL EDUCATION *and the Chemistry Leaflet.*

6.00 P.M. *Dinner.* Editors of the JOURNAL OF CHEMICAL EDUCATION and the *Chemistry Leaflet.*

THURSDAY, APRIL 10TH

8.30 A.M. Meeting of Joint Committee of the Division of Organic Chemistry and the Division of Chemical Education appointed to study nomenclature as used in teaching Organic Chemistry.

23. 9.30 A.M. GUSTAV EGLOFF AND C. D. LOWRY, JR. "Alchemical Distillation."

24. 9.50 A.M. G. FREDERICK SMITH. "Electrically Heated Sand-bath Hotplates for Analytical Laboratories."

25. 10.00 A.M. W. E. ESKEW AND FRANK C. VILBRANDT. "Duplex Weighing Tube."

26. 10.10 A.M. A. LLOYD TAYLOR. "A System of Dispensing Qualitative Analysis Unknowns."

27. 10.20 A.M. FOSTER DEE SNELL. "Generation of Hydrogen Sulfide."

28. 10.30 A.M. ARTHUR ROSE AND R. D. BILLINGER. "Approximate Molecular Weights from the Boiling-Point Rise: An Experiment in Elementary Chemistry."

29. 10.40 A.M. ROBERT F. MCCRACKEN. The "Teaching of pH and C_H."

30. 10.50 A.M. LLEWELLYN HEARD. "The Balanced Column Method for the Determination of the Density of Liquids."

11.00 A.M. *Business Meeting of the Division.*

Element 87 Traced by a New Method. A new and highly sensitive method of analysis, in which it is possible to detect one part of a compound in several billion parts of water, resulted in the discovery recently by Fred Allison and Professor E. J. Murphy of the physics department of the Alabama Polytechnic Institute of evidence of the presence of Element 87, which is one of two absentees in the world of elements.

The evidence in support of the discovery is based entirely upon this new so-called magneto-optic method of analysis which Dr. Allison and Professor Murphy have developed. By this means elements reveal themselves in chemical compounds by producing minima of polarized light at points on a scale which are characteristic of the atomic mass and valence of the element.

The discovery, if finally established as conclusive, stamps the Auburn physicists and investigators as having attained a goal long sought by leading scientists of the world. Of a total of ninety-two elements, two escaped the eyes of scientists until the discovery by Dr. Allison and Professor Murphy, which leaves only one missing, it being No. 85.

No. 87 was detected in samples of ores found near Buckfield and Norway, Me. The ores, which were supplied by the research laboratory of the General Electric Company, are technically known as pollucite and lepidolite.

Dr. Allison and Professor Murphy have consistently found in the samples of pollucite and lepidolite ores minima at points of the scale corresponding to an element of the chemical equivalent ascribed to ekacaesium, the name already given to Element 87.

The fact that the minima characteristic of an element of the properties of ekacaesium appear at the appropriate parts of the scale in the chloride, nitrate, sulfate, and hydroxide compounds of these ores affords evidence of considerable weight that the element is present in the samples under test, since by their method the compound instead of the element is detected, and different compounds of the same element appear at different regions of the scale.

A preliminary announcement of the results concerning Element 87 is being published as a note in the forthcoming issue of *The Physical Review*.

The element has not been separated chemically. Thus far, only a preliminary statement is being made by Dr. Allison and Professor Murphy while their investigations are being continued.—*New York Times*

Correspondence

CALCULATING CRYSTAL DIMENSIONS

I have read the excellent article, "Some Elementary Principles of X-Ray Crystal Analysis" in the January issue of the JOURNAL. May I make a suggestion that I believe will make one calculation used there more understandable to the average student? This refers to the calculation of the distance between the atomic planes of the sodium chloride crystal. The method of calculation I suggest is not new, of course, but I offer it because I believe it will be followed by more students because they are more familiar with density in grams per cubic centimeter than in terms of the volume of unit cubes and the atoms associated with it.

Since a mole of NaCl is 58.455 grams this weight represents the weight of $2(6.06 \times 10^{+23})$ ions of Na and Cl. Since these are arranged symmetrically in a cube we may let y represent the number of ions on an edge of a cube one centimeter on an edge. The number of ions in the cubic centimeter of the crystal of NaCl can be found by proportion as follows:

$$58.455 : 12.12 \times 10^{+23} = 2.163 : x$$

$x = 44.84 \times 10^{21}$ ions of Na and Cl in one cc. of NaCl crystal. Then, $y^3 = 44.84 \times 10^{21}$ and $y = 3.553 \times 10^7$ ions on an edge of the cube.

The distance between the atomic planes will be the reciprocal of the number along an edge (in reality the distance is $1/y - 1$ but the value of $1/y$ is accurate enough here). The distance between planes in the salt crystal is $1/3.553 \times 10^7 = 2.816 \times 10^{-8}$ cm.

R. S. HOWARD

LYONS TOWNSHIP HIGH SCHOOL AND JUNIOR COLLEGE,
LA GRANGE, ILLINOIS

CHEMISTRY AT THE UNIVERSITY OF BUENOS AIRES, ARGENTINE

The University of Buenos Aires comprises six divisions, one of which is the *Facultad de Ciencias Exactas Físicas y Naturales*. A School of Chemistry was created in this latter division at the beginning of the century and awards the diploma of *Doctor en química* (Doctor of Chemistry). In addition, there are included in this division the following Schools: (1) Engineering (civil and industrial); (2) Architecture; (3) Natural History; and (4) Mathematics, which awards the diploma of *Doctor en Ciencias Físico matemáticas* (Doctor of Mathematics).

The requirements for the chemical diploma cover a period of five years according to the following curriculum:

	Hours per Week	
First Year	*Theoretical*	*Practical*
General chemistry	3	3
Inorganic chemistry	3	6
Mathematics (algebra, trigonometry)	3	2
Geometry	3	3
Zoölogy (*A*)	3	2
Second Year		
Organic chemistry	3	6
Analytical chemistry (qualitative)	3	6
Physics (first course)	3	3
Mathematics (infinitesimal calculus)	3	3
A course in drawing	2	4
Third Year		
Organic chemistry (cyclic)	3	6
Analytical chemistry (quantitative)	3	6
Physics (second course)	3	3
Botanics	3	3
Thermodynamics (*B*)	3	3
Fourth Year		
Industrial chemistry (first course)	3	3
Biological chemistry	3	3
Physics (third course)	3	3
Mineralogy	3	3
Engines (*B*)	3	3
Clinical analysis (*A*)	3	3
Fifth Year		
Physical chemistry	3	6
Microbiology	3	3
Food and industrial analysis	3	6
Industrial chemistry (second course) (*B*)	3	3
Toxicology (*A*)	3	3

All courses, with the exceptions of those marked *A* or *B* are obligatory. The student may elect either all *A* or all *B* courses. It will be noted that the *B* courses are for those students interested in industrial chemistry.

In addition to the course work listed above, a student must present a thesis before satisfying the requirements for a diploma.

The course is given in two sessions annually—March 15th to June 30th, August 1st to November 15th.

Unfortunately, at present, the School of Chemistry is located in an old building with inadequate equipment for laboratory work. However, plans are now under way for the construction of modern laboratories.

VENANCIO DEULOFEU

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SHALL LABORATORY PERIODS BE SHORTENED?

Every now and then, for some unaccountable reason, an urge appears among certain of our colleagues to make a change in the old order of doing things. So long as it is a change, many conclude that it must be a reform and improvement, and that those who counsel caution until proof has been presented that the change is desirable, are confirmed mossbacks.

One of the more recently proposed innovations is to shorten laboratory periods from the traditional three hours to two hours for the beginning students in the various laboratory sciences. A number of arguments for the adoption of two-hour laboratory periods are given. These will be presented and the endeavor made to refute, and to show them to be invalid or without serious value. Now this privilege is not to be extended to those students who are carrying laboratory courses advanced beyond the beginning one. The latter are to do three hours' laboratory work for one semester hour of college credit; the beginner only two for the same number of credits. When the illogic of this plan is pointed out, *i. e.*, that the more advanced student with laboratory experience is being asked to perform one and one-half times as much for his credit, and that the more logical arrangement would be to reverse the requirements, they naïvely reply, that the student should not emphasize the importance of credits and besides aren't the second- and third- and fourth-year men in the sciences taking these subjects because they want to or because they must? Well, the beginner is taking the course for the same reasons—as nearly as these reasons can be analyzed—because he expected to major in the subject, enter a profession in which it is a requirement to meet the college demands that he study a laboratory science in order to earn a degree, or finally because he was placed there by the person who registered him. These reasons for electing the course would hardly warrant the extension of any favors to him that should be withheld from his older, college brother.

The writer is enough of a Jeffersonian Democrat to wish that every man on a faculty be granted as much freedom in the policy of his department as can be given without harm to the general welfare of the institution. However, the permission to one department to give an hour credit for two hours of laboratory work is a permission that concerns not only that department but every other one on the campus. The custom has been to require three hours' laboratory work for one college semester credit and any change in this policy should be taken with the publicly expressed approval of the faculty. Furthermore, the requirement of two hours' preparation for every hour of classroom performance or a total of three hours has been presented to students as a necessary minimum requirement for earning a college credit. Now if two hours of laboratory work earn one college credit, does it not seem illogical, possibly even unfair, to ask two hours

of preparation for every classroom lesson? Can less preparation be safely given to a lesson with assurance of a creditable showing in a course? But isn't there a certain unfairness if we adopt two-hour periods for the laboratory and assign lessons that require two hours of preparation? Those institutions that place little stress on credits but have a requirement of a final comprehension examination to test the student's accomplishment are relieved of this problem.

That students value college credits is not to be wondered at when one considers the importance attached to them by their teachers. They must earn one hundred and twenty-four semester college credits for a diploma—a faculty ukase.

When one proposes that in fairness the credit for two-hour laboratories be two-thirds of an hour, the suggestion is met with the objection that this would introduce common fractions into the registrar's office. If fractions are as difficult for registrars as they are for the students in beginning chemistry, the objection is a valid one. On the other hand, I am certain that the students in the more advanced courses will object to the disproportion in credits earned. Could I be assured that the adoption of the two-hour laboratories limited to beginners would arouse the ire of the other students to a pitch whereby a reform of the present credit system would result, I might consider advocating its adoption.

Another argument for the two-hour laboratory period is that students waste too much time in the three-hour period and that they can do as much work in the two. A waste of time by students certainly can be corrected by the instructor in charge. If he is unable to do so for the three-hour period, how will he succeed in the two? As to the relative amounts of work accomplished—in one case there is one and one-half times as much time for work—surely a student can do more in three hours than in two. However, the disparity in time that is devoted to actual laboratory work is greater than actually appears at first sight. Let us analyze a few of the activities of the student in the laboratory. The average laboratory period goes somewhat like this: the student spends ten minutes opening his locker, selecting his apparatus for the experiment and listening to any general instructions from the laboratory instructor; ten minutes consulting his laboratory manual; in case he needs a piece of apparatus not in his desk, another ten minutes getting it from the storeroom: two or three weighings will require ten minutes time from the beginner; and dismantling set-ups, washing apparatus and the desk top at the end of the period, etc., can easily consume twenty minutes—a total of one hour. One hour remains from the two-hour and two hours from the three-hour laboratory. The time for experimental work is not one and one-half but two times as much for the three-hour period; a most favorable situation for the three-hour period that too often receives no appreciation. This is

exclusive of the time needed for making some sort of notebook record of the experiment. The writer believes that to insure that these records be the student's own independent work, they should be made before the student leaves the laboratory. The student then has the advantage of consultation with the instructor in case any point of the day's assignment is obscure. If fifteen or twenty minutes are used for this purpose we now have less than half as much time in the two-hour laboratory period as in the three-hour laboratory period available for laboratory experimentation.

That students cannot concentrate for three hours is an objection presented. Can they for two hours? The usual laboratory work is varied enough in character that the student's mind is diverted and the longer period, since it promotes a somewhat leisurely attitude, is not so wearisome mentally.

It gives time for a consideration of the purposes and results of the experiments, which the two-hour period certainly does less adequately. The shortened period will discourage the inclusion of experiments with somewhat complicated set-ups and reactions that require time for completion. These are those which illustrate the important principles of the science and exercise the student in manipulation so that he acquires skill in this phase of the science.

I am not opposed to a shortened period for those students who accomplish the assignment in less than the average time, but when the period is shortened to two hours it becomes more difficult to observe any discrimination for the able, average, and dull students. With the educational program as it is, the State Schools at least have all these classes and have an implied obligation to do their best by all three classes. The three-hour period possesses an elasticity that is absent from the two-hour period. If the two-hour period is organized to occupy the time of the able student, how about the average and the dull? If organized for the average, how about the able and the dull? I refuse to consider the possibility that it should be planned primarily for the dull. I appreciate that every student should be treated as a special problem and his work planned with him, but with the teaching staff of the present size, this is an impossible task—with the beginners at least. But when it is found that the average students are able to complete the assigned work in the two hours, only under high pressure, and the dull students not at all, the normal inclination of the instructor will be to lighten the assignments or accept work of a lower quality, and the standard of the work of the college will be lowered just that much. If the two-hour period is adopted, this lowering will take place just as soon as the zeal of the advocates for the change has cooled.

The disadvantages of the two-hour laboratory courses and the obvious advantages of the three-hour laboratory period which have been presented,

seem to me to justify the retention of the latter plan and the rejection of the former. The writer realizes that the advocates of the two-hour plan may have some data that have not been brought to his attention. He is always willing, nay, anxious to be informed.

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Scientific Investigations of Spontaneous Combustion Proposed. The strange phenomenon of hay racks catching fire through no human agency was recognized as a natural process by wise men of old Rome, and yet two thousand years later the process is still as baffling and inexplicable to modern science as it was to Columella and Pliny. Citing the knowledge of ancient observers regarding spontaneous combustion, Dr. Henry G. Knight, chief of the U. S. Bureau of Chemistry and Soils, speaking before the recent conference on Spontaneous Heating and Ignition of Agricultural and Industrial Products, outlined a program of scientific research which would solve the mystery and enable mankind to forestall the destructive process.

"There is evident need of careful investigation of the exact conditions that produce the spontaneous ignition of agricultural materials as the basis for our future course of action. It will require a coöperative investigation by chemists, bacteriologists, and engineers upon quantities of materials sufficiently large to duplicate actual farm conditions."

Outlining the points requiring special attention, he said:

"Chemical analyses should be made of the fresh material and the chemical changes which take place throughout the heating period should be noted carefully. The rate of heating in different parts of the mass should be determined. The avidity for oxygen of the fresh and fermented material should be studied. The migration of moisture throughout different parts of the experimental material should be carefully observed. The production of gases and their character should receive study. The effects of aeration at various stages of storage should be recorded. Studies of conditions existing in the areas of high heats should be carried on, and the various methods of curing in the case of hay and the effects of adding other substances such as salt to hay and to cattle feed should receive special study. Along with this work and based upon it should be studies of methods directed at the reduction of spontaneous heating and actual firing of agricultural materials."

Spontaneous ignition costs American farmers millions of dollars a year, and the chief products which go up in smoke or are spoiled for use by this cause are hay, grain, and horse manure.—*Science Service*

Five Hundred Tons of Aspirin a Year. Deaths from poisoning by aspirin (says the *Pharmaceutical Journal*) are on the increase in England and Wales according to the Statistical Review of the Registrar-General. This is not surprising in view of the quantities of the drug (500 tons a year, according to Dr. Dishington) consumed in this country. The significant fact is that there has been a big jump in aspirin fatalities. In 1927, five people met their deaths, by intent or accident, through taking aspirin, while in the year before there was no recorded case. In 1928 the number was seventeen —ten accidents and seven suicides. That there is a moral to draw from these figures is obvious.—*Chem. News*

Chemical Digest

ON SIXTY DOLLARS A WEEK

Since the series of articles on "The Economic Status of Scientific Men and Women" appeared in *Science* last July[1] we have kept them on our desk with the idea of really digesting for our readers the material contained therein. But, as is so often the case, more than good intentions are necessary to produce results. And the more we've studied these articles the more convinced we've become of our inability to do justice to such a vital subject. To our rescue has recently come the Shop Philosopher of *The Kalends* of the Williams & Wilkins Company,[2] whose comments we herewith publish with our hearty endorsement.

Sixty dollars a week is good money. What there is of it. From a series of studies recently published in *Science*[1] it appears that sixty a week represents the average normal pay of a teacher in an institution of higher learning.

It seems scarcely adequate. It is about five dollars a week short of the average salary of the executives in the Dual Organization, the salaries of administrative officers being excluded from the computation.

But if inadequate, what of it, so long as the profs don't rip and tear? Well, a good many things. There is no occasion to become sobsisterical about it, for sixty a week is a long way ahead of starvation. Reflect upon the matter therefore, not sentimentally, but as a sociological phenomenon, one which has wide personal implications.

Sixty bucks, I say, is good money. It means to John Jones a pretty fair degree of comfort; lots of John Joneses would leap at it as affluence. But Professor Johann Johnes has expenditures that John Jones needn't worry about.

The professor must keep growing, and classroom work alone does not give him adequate nourishment. There are societies to belong to, meetings to attend, sometimes assistance to employ, equipment to be purchased, private research experiments to be conducted, students to entertain—a long list of things not merely desirable, but also quite essential. The *Science* articles intimate that $300.00 to $400.00 a year for such professional needs is a minimum requirement. That seems rather modest. I should put the minimum at $600.00, and the maximum all the traffic will bear.

Once again, the standards of society, the pressure of what is expected, combined with a decent self-respect, demand that the prof shan't live stingily or poorly, out at elbow in a hovel. Within the school community, at least, he is in the public eye and the economies of obscurity are not possible to him. So by the time the prof takes off for professional and extra personal expenditures what he ought to take off, the pay-envelope is looking pretty groggy.

No, it isn't adequate. Especially it is inadequate in relation to the time, money, and energy spent in getting fitted for the job. There are long years of costly preparation, a considerable investment, oftentimes a deal of self-sacrifice. From the sole viewpoint of lucre, it isn't worth while.

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[1] Pages 19–29 (July 12, 1929) and pages 47–59 (July 19, 1929). For titles of references see page 933 of the Abstract Section of this issue of the JOURNAL.

[2] *The Kalends*, **9**, No. 2, 7–10 (1930).

Why then do first-class men bother about the job at all? There's the rub. Maybe they won't. In fact it would seem to the casual onlooker that most certainly they won't—that, in increasing degree, the best men will find less precarious pickings elsewhere and that the chairs will be occupied by those without ability to catch on elsewhere.

Certainly conditions have arrived at no such critical stage as yet, but one cannot defy the course of logic of economic events. Furthermore, it is reasonable to suppose that even today the colleges have lost many able men who might have been saved to them.

This is, don't you know, a pretty warm subject. Evidence from all sources points to a greater and greater college population. Perhaps most of that population is, at the college years, out of touch more or less with the parental roof-tree. Largely it is the prof's responsibility to stimulate, challenge, inspire, in brief, to educate, the leaders of the coming generation on which—by and large—this generation will depend for support.

What sort of men do we wish to commit the development of our future meal-tickets to? Men of vitality, certainly. Men who command and demand respect. "Regular" men, neither fussy old hens nor prosy pedants. Now the smoke and the strife of the economic scramble do not tend to destroy the *élan*, provided that one is in a position to mix it in the arena with the other buyers, sellers and exchangers and at least have a shot at his share of the loot. But this is exactly what the prof cannot do. He is a trainer of embryo gladiators, who usually have no loot as yet, and so he is dependent on what the backers of his charges toss out to him. And that is just the point. It is almost inevitable that the trainer will, some time, begin to measure the worth of himself and his services by the apparent value which those for whom he is working place upon them.

Then what happens? If he is the ideal type for training gladiators he is probably a considerable gladiator himself. The arena is in front of him, with its spoils. So he steps into it. This is neither mercenary nor selfish. It is all but inevitable in a man who feels that he can hold his own anywhere and is willing to take the chance of hard knocks. The man who lacks self-confidence stays, perhaps; and one pictures his inferiority complex growing from year to year.

Of course, the figure cannot be pressed too far. Men are of many temperaments and motives animate them other than the love of comfort or of affluence. Really that motive probably isn't important. What is important is the self-respect which demands a decent outlet. A man compares his income with one four or five times as great, derived by someone who, he feels sure, has no more brains, uses no more energy than he does himself. He is almost sure to wish to try personal conclusions with the world at large, if for no other reason than to certify himself to himself.

Certainly there is no job more important to the general welfare than the training of young men and women. Certainly that training will pass into less competent hands if adequate compensation is not given to more competent ones. The investigators who report in *Science* say that more than half the college men supplement the income from outside sources; and that moreover, the percentage of those who do so rises as the grade rises from instructor to professor. This may mean that economic pressure is even greater in the higher grades than in the lower, but I should judge that factors other than economic pressures are at work. Men who have pushed to the top are likely to be in greater demand; they are given more opportunity for supplementary work of the sort that is particularly inviting, that is to say both flattering and lucrative. This in turn must mean that the time given to extramural work is taken from teaching—and so the training falls more and more into the hands of the young or the less noteworthy. The man of note has engineered a partial divorce from the college; his name

remains, but it is, in greater or less degree, mere academic scenery. It seems obvious that, in moderation, extramural activities are desirable as a prophylactic against hermetic professorial sealing. But carried too far, it is robbery of the succeeding generation, a stealing from the goose who is presently to get into the golden-egg trade.

Another consideration is disturbing. Probably there will never be any dearth of mere *numbers* of persons willing to teach at whatever stipend may be offered. This serves to obscure the issue; for naturally no one is going to pay more for a service which can (apparently) be purchased for less. Supply and demand should theoretically keep the situation in balance and almost automatically dictate the amount to be paid. But to follow this "law" in this case doubtless means only that the supply will keep up, but it will be the supply of an inferior article where society requires the very best.

During the last few years the standards have been raised, apparently—actually for all I know. That is to say, an M.A. or a Ph.D. is required beyond a given point. But is this a real measure? The general impression is that a Ph.D. is not, of itself, sufficiently indicative. It may be acquired by a really quite mediocre mentality; and on the other hand, it may not be in possession of one ideally suited to and qualified for the task of higher education. The point here is that society cannot assure itself of the best material by the sole test of subjoined letters and so much volume of formal schooling. That filter may be used, an adequate numerical supply of Ph.D.'s will still be forthcoming at sixty a week, yet the quality may still run down. Of course, one cannot say that this has been or will be the course of events. But there is quite clearly the hazard that it will.

Whoever selects faculty personnel must select the best from what is offered. If no one hundred percenters are offered then nineties or eighties or sixties or fifties must be taken. They may have all the labels the hundreds have and superficially appear just as good. That is what makes it hard to suggest to the selecters that they increase their bids; they can get the article for the money they pay now.

Yet the arbitrary increase of the bid seems the only way to assure the attraction of the one hundred percenters. You can't trap a lion with four ounces of liver—not regularly. And this means arbitrary increase at the bottom and through the intermediate grades as well as at the top. The top men are, I suppose, already being bid for; supply and demand take care of that, it may be. But a few scattered prizes, so few as to reward only a small proportion of the meritorious, will not attract men of the first quality to college teaching as a career. There must be reasonable assurance that making good will lead to substantial compensation. If it does, then the right man will be willing to trust to luck to land one of the prizes.

Arbitrary increase of wages, as a policy, has at least two very weighty objections, however.

The first one is that arbitrary increases seldom if ever have the desired effect, *i. e.*, improvement of the quality of the service. In this case the answer seems reasonably easy. Let the increase be assigned to that expense of the prof which makes his economics differ from the average—his professional needs. That is to say let faculties be entitled to an allowance for professional needs, ranging from, let us say, $600.00 to $2,000.00 each. Arrange so that the prof must spend the amount for this purpose or not at all. This will release a like amount for household and ordinary expenses and be tantamount to an increase. It will also insure, so far as such a matter can be insured, the continuing development of the prof—and serve to identify those who are too indolent or too unambitious to call for the allowance.

The second objection is the time-honored one of what standard to use for money. I wonder what the average salary of football and athletic coaches, trainers, assistants, and rubbers is? I have a hunch that it is better than sixty a week. Possibly if scholastic

attainments loomed as large as athletic prowess, if colleges endeavored to win publicity on the success of their faculties in making human units of economic and social value rather than on the success of their students in making touchdowns, there might be less difficulty about the money.

Maybe it's a question of where the emphasis is placed—not only by alumni, college trustees, and administrators, but by society at large.

CHEMICAL RESEARCH IN CZECHOSLOVAKIA*

At the beginning of last year the Czechoslovak chemists founded a monthly journal in which original contributions have since been published either in English or French in order to make known to scientists at large that much research work was being carried out in pure science at the universities and technical institutes of that country. The *Collection of Czechoslovak Chemical Communications* has published original articles covering the whole field of pure (but not applied) chemistry, and some of them are particularly noteworthy.

PROF. EMIL VOTOCEK, with his collaborators, DRS. F. RAC, L. RYS, and S. MALACHTA, has made a study of the methyl-pentoses, the hydrazones and osazones obtained by the interaction of di- and trichloro-phenylhydrazines with various aldehydes and ketones. In particular he has utilized the results of these investigations in identifying the less well-known hexoses and pentoses, and has thus added to the knowledge of the carbohydrates generally. He has also studied the conversion of certain sugars into furane and hydro-furane derivatives.

In physical chemistry, PROF. J. HEYROVSKY (the other co-editor of the *Collection*) continues to publish fresh investigations made with his polarographic arrangement and dropping mercury cathode apparatus. The latest papers from his laboratory deal with the electro-reduction of arsenious oxide in acid solution (by MISS K. KACIRKOVA), the deposition of zinc and of cadmium from alkali cyanide solutions (by DR. I. PINES) and the influence of fatty acids on the maximum of current due to atmospheric oxygen (by DR. J. RASCH). The same method has been employed by PROF. HEYROVSKY and DR. TERECHOV in a study of the acidity of mannitol toward alkali hydroxides, and the apparatus is also finding application in the detection of smal amounts of impurities in reagents and in micro-analysis.

Of the papers dealing with analytical chemistry there are two by DRS. JILEK and LUKAS describing respectively a new rapid electrolytic method for estimating bismuth in acid solutions, and an electrolytic method for the determination of thallium as thallic oxide. In the same branch, DR. S. LANDA has devised a convenient apparatus for the estimation of sulfur in organic liquids. PROF. O. TOMICEK has been engaged upon an examination of the various argentometric titration methods that have been proposed for the determination of mixed halogen salts and he has modified the more suitable ones to his determinations of the small amounts of bromine and iodine in the numerous Czechoslovak natural mineral waters, and the saline products obtained therefrom by evaporation. His results are valuable since he has found the limits of reliability to be placed upon the figures found for the amounts of iodide and bromide when admixed with a large excess of chloride.

Work has also been carried out upon the hydrolysis of beryllium salts, and the influence of alkali metal ions upon the precipitation of zinc ferrocyanide. Finally, two chemists at the Masaryk University of Brno have made an exhaustive study of the additive compounds of organic bases with the inorganic salts of certain heavy metals, in-

* *Science Progr.*, **24**, 499–500 (Jan., 1930).

cluding copper, zinc, lead, and the alkaline earth halides. The *Collections* also occasionally include reviews and bibliographies of articles in pure and applied chemistry by Czechoslovak scientists. Those so far given contain some hundreds of references to papers published within the last two years, and from this it is apparent that there is considerable scientific activity in Czechoslovak universities and research institutes.

U. S. Department of Agriculture Plans Manifold Researches. Lighted cigarettes carelessly thrown from windows have become such a fire menace that an item of $7000 in the Agricultural Appropriation bill, now before Congress, has been specified for research by the U. S. Bureau of Chemistry, looking toward fireproofing cotton cloth such as is used for awnings. Such a method, if successfully developed, it is estimated, would increase the sales of cotton cloth used for outdoor purposes from $70,000,000 to twice or three times this amount.

The cotton cloth fireproofing experiments are only one part of a series of interesting investigations important to industry which the Agricultural Department is to undertake in coöperation with other government agencies next year, providing Congress allows the increase of $53,430 for industrial investigational work, which has been approved by the Appropriations Committee.

The Bureau of Chemistry wishes to investigate chromium plating in order to discover whether there could possibly be any menace to health in connection with its use in food utensils. Similarly, it is desired to study the possible slight or cumulative poisonous effects to the human body, that might be attendant upon the use of new spray materials in producing fruits and vegetables.

Three new fumigants have been developed by the Department, ethyl formate, ethylene oxide, and ethylene dichloride. These are widely used, and a check-up on their effects is desired.

Funds totaling $14,000 are asked for research on the chemical structure and economic uses of lignin, an amorphous, resinous substance in woods and in practically all plant materials. It is left in cornstalks when the cellulose is taken out for paper-making. Its use in the making of resin or dyes seems to be indicated. So complex is the chemistry of this substance that it is believed it may be many years before very much is known about it. Chemists are said to be anticipating great industrial developments from the use of lignin, comparable to the rayon, lacquer, and film industries which have come as a result of the detailed study of cellulose. Foreign chemists, it is said, are now turning their attention to lignin research, and it is believed probable that the country which first comes to understand this substance may reap large rewards.

The uses of furfural, Dr. Henry G. Knight, chief of the Bureau of Chemistry pointed out to the Appropriations Committee, would seem to be a parallel, indicating that lignin must have economic possibilities. Furfural is obtained from oat hulls and other wastes, and is now produced as a side-line by a breakfast food concern for eleven cents per pound. It can be used for making telephone mouthpieces, door knobs, penholders, ink-stands, electric fixtures, and airplane parts.

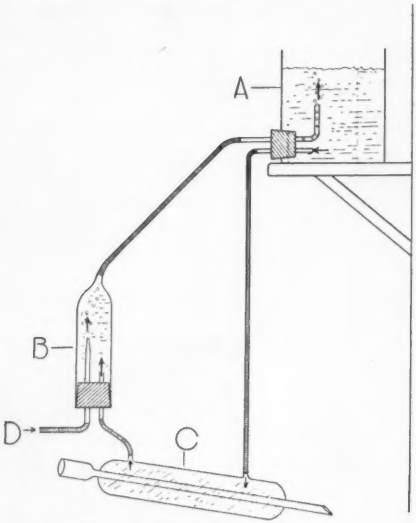
Dextrin from sweet potato starch, on which the Bureau of Chemistry is working, Dr. Knight said he believed would eventually prove a satisfactory adhesive for postage stamps and fine stationery. Because people insist upon licking these and therefore tasting them, the glue used must not be offensive. The adhesive now used is made from tapioca.

Among the new oils on which the Bureau has worked during the past year are walnut oil made from waste walnut meats, tomato-seed oil, and avocado-seed oil. The walnut oil is largely used in paints, but also has some use as a salad oil. The other two oils are used in soap manufacture.—*Science Service*

ABSTRACTS*

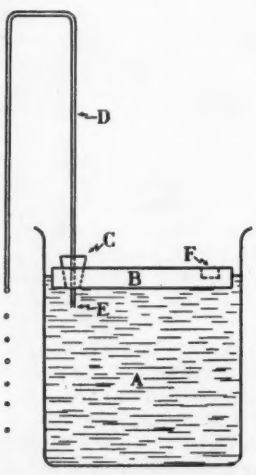
APPARATUS, LABORATORY PRACTICE, AND DEMONSTRATIONS

An Efficient Cooling System. O. L. BARIL. *Hormone*, **4**, 13 (Jan., 1930).—By passing air bubbles through the outlet tube of the water condenser by means of compressed air a continuous stream of ice water may be made to flow through the condenser, as is shown in the diagram. Since the same water is used over repeatedly, salt may be added to the ice and water. This cooling system has been used with satisfactory results in distilling liquids of low boiling points. R. L. H.

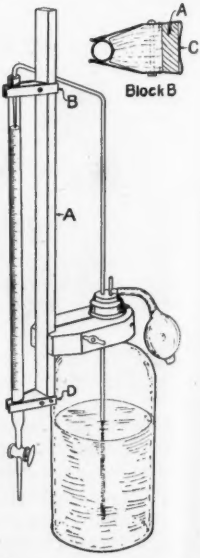


A—COOLING BOTTLE
B—20 MM. GLASS TUBING DRAWN OUT TO 3 MM. AT ONE END
C—CONDENSER
D—COMPRESSED AIR INLET

Device for Maintaining a Constant Rate of Flow of Liquids. J. D. SULLIVAN. *Ind. Eng. Chem., Analyt. Ed.*, **1**, 233 (Oct. 15, 1930).—A simple apparatus to insure a drop-by-drop rather than a continuous flow of liquid for leaching purposes. The figure is practically self-explanatory. *A* is a beaker, jar, crock, etc.; *B* is a piece of wood cut in a circular form, of diameter slightly less than that of the container, *A*; *C* is a cork which fits into a hole bored in the float, *B*; *D*, a piece of glass tubing bent so as to act as a siphon, passes through cork *C* and down into the solution in *A*. The siphon may be raised or lowered by moving the glass in *C*. For a very slow drip the end of tube *E* is constricted. *F* is a hole to accommodate lead shot for balancing purposes. D. C. L.

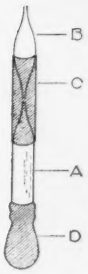


Buret Clamp and Holder. M. HOLLINGSWORTH. *Ind. Eng. Chem., Analyt. Ed.*, **1**, 233 (Oct. 15, 1929).—The construction of the buret clamp and holder shown in diagram is given in detail. Advantages claimed for this clamp are: entire buret scale is always free; buret may be removed or inserted with one hand; clamp may be used either end up, and when made long the buret may be placed in any elevation relative to the bottle—op-



* *On pages 957–70 of this issue will be found information concerning the periodicals abstracted by the* JOURNAL.

posite, above, or below; buret is held so rigid that the upper end of the supply tube may be drawn to small bore and the end inserted through a grooved cork, set opposite the zero mark on the buret. This gives zero adjustment when the buret is filled and the pressure within the bottle is released. D. C. L.

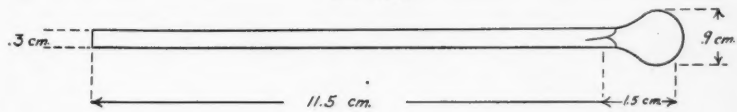


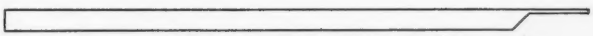
Pyknometer and Pipet. O. L. BARIL. *Hormone*, **3**, 136–7 (Dec., 1929).—A pyknometer may be made for small amounts of liquids by drawing a piece of glass tubing to capillary size at each end (*B*). This connected to a medicine dropper (*A*) by a piece of rubber tubing (*C*) provides a means for filling by pressing and then releasing the rubber bulb (*D*). The pyknometer bulb may be standardized and used for a pipet. R. L. H.

Permanent Markings for Laboratory Porcelain and Glassware. A. A. HIRSCH. *Chem.-Analyst*, **19**, 18 (Jan., 1930).—Permanent markings of superior quality may be made with ordinary blue-black ink by marking the clean dry surface with a pen using sufficient ink to give a continuous opaque film. When dry it is heated with a Meeker burner, finally allowing the flame to bear directly on the marking. A successful marking is reddish brown, smooth, homogeneous without any appearance of external roughness. This idea was also utilized in marking weights on Pyrex beakers used as drying dishes. D. C. L.

Nickel Spatulas. T. L. KELLY. *Hormone*, **4**, 15 (Jan., 1930).—Spatulas may be made from nickel wire, Brown and Sharpe No. 7, which makes a permanent article in the laboratory. These are not harmed by heat and are free from corrosion. R. L. H.

TOP VIEW





SIDE VIEW

The Stalagmometer. C. J. HAGGERTY. *Hormone*, **4**, 12–3 (Jan., 1930).—Only one laboratory manual of physical chemistry (Daniels, Mathews, and Williams) contains experiments using the stalagmometer for the determination of molecular weights and to study other physical properties of liquids. The molecular weight of a liquid is determined by the drop weight method, in which the weight of a single drop is determined and the molecular weight calculated from the formula of Morgan, $w(MV)^{2/3} = K(t_c - t - 6)$ wherein w is the weight of a single drop, M the molecular weight of the liquid, V the specific volume, t the temperature of experiment, t_c the critical temperature, and K a constant for the particular stalagmometer. R. L. H.

Determination of Inner Area of Dishes. W. R. SMITH. *Chem.-Analyst*, **19**, 15 (Jan., 1930).—This is often desirable, especially in electrolytic work. A film of collodion is formed on the inner side of the dish by pouring some collodion into the clean dish and rotating until the inside is completely covered. It is then removed with slightly warmed water. While still damp, it is cut into four convenient pieces placed on a good grade of bond paper and tracings made. These are then cut out, dried, and weighed. By comparison with a piece of known area and weight, the area of the dish is determined. D. C. L.

Suggestions for Laboratory Manipulation. H. L. JACKSON. *Rep. New Eng. Assoc. Chem. Teachers*, **31**, 77–85 (Jan., 1930).—Expensive apparatus is not always the best and many simple devices and articles of every-day use are very handy in the laboratory. A description follows of a wash-up sink, draining board, clean-up corner, fireless cooker for temperature work, steam-bath, home-made hektographs and several other very useful pieces of apparatus. O. C.

Easy and Quick Way to Clean Distillation Flasks. H. L. KAUFFMAN. *Chem.-Analyst*, **19**, 18 (Jan., 1930).—A cleaning swab is made by taking a wire of copper, iron, or steel of convenient length, about 12 to 14 inches and about $^1/_8$ to $^3/_{16}$ inch in diameter, bending one end into a shape convenient for holding. To the other end is fastened some steel wool by using fine wire, making sure the tip is well padded. The swab is most effective when flasks have drained fairly dry. This method has been used on distilling flasks in oil refineries and found much simpler and more effective than the usual methods of using cleaning solution, shaking with sand and fine pebbles or shaking with steel filings. D. C. L.

Suitable Oil for Oil Baths. T. L. KELLY. *Hormone*, **3**, 136 (Dec., 1929).—Objection was found to the use of lubricating or high flash point for oil baths due to the fact that the oil smoked excessively long before the flash point was reached. Instead of the ordinary lubricating oil an oil known as "Alaska Cylinder Oil," sold by the Standard Oil Company of New York, was recommended. This oil has a flash point around 300° C. and smokes only slightly at 210°C. R. L. H.

An Automatic Balance. W. C. OELKE. *Hormone*, **3**, 137–8 (Dec., 1929).—The balance consists of a beam, which has a pan attached to one end and a counterweight to the other. The beam is then placed on a knife edge so that the counterweight overbalances the empty pan by exactly 0.2 g. The balance is recommended for use in qualitative analysis where ordinarily accurate weights are desired, and at the same time rapid weighing may be realized. The balance is said to be sensitive to 0.01 g. Full-page diagram accompanies note. R. L. H.

Rendering Refractory Oxides Soluble. G. W. POWELL. *Chem.-Analyst*, **19**, 10 (Jan., 1930).—In the analysis of roasted nickel mattes, it was found that some of the nickel oxide was almost as refractory and insoluble as the insoluble impurities. By making a low-temperature fusion with flowers of sulfur, the resulting sulfide was readily decomposed by acid. Crucible should be covered, temperature not too high, and when nearly all sulfur has been expelled, held at low red heat for complete expulsion. When ground it is easily decomposed by acids. This method could be applied to other analyses. If excess sulfur remains, it will float on top and must be removed, or may be oxidized. D. C. L.

Modern Methods of Ascertaining Specific Gravity. W. A. BENTON. *Chem. & Ind.*, **48**, 1145–52 (Nov. 29, 1929).—A critical discussion of some of the methods available for the determination of the specific gravity of liquids, solids, and gases. Among the instruments mentioned are Avery gravitometer for solids, the Mohr-Westphal balance, and the Avery liquid density balance. E. R. W.

The Removal of Interfering Acids Prior to Systematic Metallic Analysis. L. J. CURTMAN AND M. WIGLER. *Chem. News*, **139**, 353–5 (Dec. 6, 1929); 369–71 (Dec. 13, 1929).—It is shown that the acid analysis should precede the examination for metals in systematic qualitative analysis, thus reversing the conventional order. The acids which interfere with the metallic analysis were subjected to an experimental study, resulting in the proposal of a systematic procedure for the elimination of all the interfering acids. A series of test analyses is included. C. E. M.

Notes on the Tests for Isopropanol. H. LEFFMANN AND C. C. PINES. *Am. J. Pharmacy*, **102**, 39–43 (Jan., 1930).—The alcohol, C_3H_8O, was first isolated from the marc of grapes by G. Chancel. Its formula placed it between ethyl and butyl alcohols. C. Friedel (1862) obtained the alcohol by prolonged action of sodium amalgam on acetone. Kolbe (1863) suggested that its name should be "monomethylated ethyl alcohol." At present two forms of propanol are recognized. By treating some hydrocarbons found in natural gas an impure isopropanol is obtained. Research has been actively searching for a dependable test for it. The obvious procedure would be to take advantage of the fact that secondary alcohols produce ketones on restrained oxidation, while primary alcohols yield aldehydes. This is complicated by the fact that acetone is not easily detected in the presence of much aldehyde. The acetone-production method for the detection of all commercial forms of isopropanol may be found described in *Pharm. J.*, **116**, 630 (1926). The Dale-Simonds test is especially convenient, distillation not being required. To 1 cc. of sample add 1 cc. sat. sol. of Na_2HPO_4 and 3 cc. sat. sol. of $KMnO_4$. Warm but do not boil. Allow it to stand until the $KMnO_4$ is completely decomposed. Add 3 cc. of a 10% sol. of NaOH and 1 cc. of a 1% sol. of furfural and filter. Add 1 cc. of filtrate to several cc. of strong HCl. Warm slightly. Isopropanol is shown by a marked color ranging from pink to cherry red. The test depends upon the formation of acetone-furfural and its strong color reaction with HCl. Small proportions of commercial isopropanol can be recognized by this test, but if comparatively large amounts (20%) of propanol, *n*-butanol, iso-butanol, or secondary butanol are present, deep red liquids

will be obtained which may lead to the wrong conclusion. With present tests isopropanol in commercial alcohol or spirits can be detected with certainty, but if any intermediate products become cheap enough to be used as adulterants, the present available tests will not be sufficient. G. O.

The Micrometric Muddle. J. P. CAMP. *Science*, **70**, 453 (Nov. 8, 1929).—The symbol $\mu\mu$ means to most chemists and biologists the 10^{-6} part of a millimeter and may be called millimicron or micromillimeter. Physicists mean by the same symbol the 10^{-9} part of a millimeter and call it micro micron. The unit 10^{-6} to the physicist is a millicron expressed by the symbol $m\mu$.

The physicist's interpretation is that of the United States Bureau of Standards. G. H. W.

M Mu versus Mu Mu. H. S. UHLER. *Science*, **70**, 606 (Dec. 20, 1929).—Prof. Kayser in his "Lehrbuch der Spektralanalyse" (1883) considered the symbol μ to refer to the thousandth part of a millimeter, while its derivation indicates that it should refer to the millionth part of a meter. The two lengths are the same but the use of μ to mean a thousand leads to error in interpreting the symbol $\mu\mu$. Most of the confusion in terms may be traced to this origin.

Dr. Hugo Erdmann (1893) called attention to a logical system of notation. His table is:

$1\text{m} = 10^{0}\text{m}$	$1\mu = 10^{-6}\text{m}$	$1\mu\mu = 10^{-12}\text{m}$
$1\text{mm} = 10^{-3}\text{m}$	$1\text{m}\mu = 10^{-9}\text{m}$	$1\text{m}\mu\mu = 10^{-15}\text{m}$

This is the only permissible interpretation of symbols if one grants the metric unit of length to be the meter and m and μ to mean a thousandth and a millionth, respectively. G. H. W.

TEACHING OBJECTIVES, METHODS, AND SUGGESTIONS; CURRICULA

Why Study Colloid Chemistry? J. H. MATHEWS. *Chem. Bull.*, **17**, 3–5 (Jan., 1930).—Rowntree observes that the living cell involves a colloidal arrangement of complex bodies, and that a complete solution of the problem of life and the difference between health and disease will be materially aided when the properties of colloids and the laws governing their activity are thoroughly understood. Colloid chemistry is in medicine and physiological science. We turn to agriculture and its products, and find—colloids. The geologist and mineralogist are finding colloid chemistry a powerful tool. Petroleum industries offer problems galore in which colloidal behavior is important, *e. g.*, lubrication. Large industries are interested in properties of colloidal substances; such as protective coatings, plastics, rubber, paper, textiles, etc. "Why study colloid chemistry"—and all industry is asking for men trained in this field? "One might as well ask, 'Why study Chemistry?' " Relatively few of the American universities are offering advanced training in the field. Research in colloid chemistry presupposes a thorough grounding in the five main branches of chemistry as well as in physics and mathematics. H. T. B.

The Influence of the Teaching Viewpoint on Laboratory Practices. C. E. PRESTON. *High-Sch. J.*, **12**, 207–19 (Oct., 1929).—Science teachers should frequently ask themselves the question, What are we trying to accomplish? Unless we do this we are in danger, through our interest in details, of losing our perspective and building a structure that is warped and unsymmetrical. We need to make a conscientious analysis of our objectives because our methods, our choice of subject matter, and the character of our testing ought to vary with our objectives. Shall we have more or less demonstration work, separate laboratory rooms and classrooms or combined laboratory-classroom, individual or class-experiment type of laboratory work, fill-in-blank or complete write-up type of note-book, are among the questions discussed by the author. C. M. P.

Chemical Education at Johns Hopkins. *Syracuse Univ. Alumni News*, **11**, 8 (Feb., 1930).—An outline of the course of training being planned at Hopkins for prospective leaders in the field of chemistry. M. W. G.

The Components of a Cultural Curriculum. A SYMPOSIUM. *Gen. Mag. Hist. Chron.*, **32**, 153–73 (Jan., 1930).—Says I. A. Pennypacker, "A curriculum selected for an ideal American college, with a view to the development of the mental powers, the understanding of other men through sharing their general knowledge, and the understanding of the relevant conditions of life, must include: English and at least one other modern language, history, mathematics, politics, economics, and physical science." A. G. Dickson, "no university which aims to produce culture can abandon the teaching of the classics, nor be condemned as retrograde merely because it does not furnish every

form of special training." A. Felix du Pont is a strong believer in the study of Latin and Greek. G. Valentine Smith quotes one of international note as follows, "Squeeze the classics out of the education of the leading nations of the world and another Rennaissance will be necessary to restore that touch with the past that is so essential to learning."

Charles W. Burr, a neurologist, says that the student must be trained to think scientifically; that a scholastic education should be offered only to the congenitally scholastic minded.

C. N. B. Camac stresses the personal influence of the cultured teacher, and especially the teaching of the classics. Thos. B. Prichett would like to see Latin made mandatory for the entire course. Clarence C. Brinton urges a return to the old standards—the classics and a cultural education. Hugh W. Ogden thinks that the broad classical training brings visions and dreams unknown to the man of narrow technical training. The only consolation of these latter is that they never know what they miss. In the opinion of Wm. P. Gest, the college department should include in its curriculum Latin, mathematics, history, literature, one modern language, and a few electives, including Greek.

Bishop Wm. P. Remington says that if materialism is the goal of modern American education, by all means cut out the classics. He thinks the universities should prescribe a course of reading for the graduates, since in their teaching they have only laid down the foundation of sound learning.

L. L. Smith, J. J. Thompson, J. Norman Henry, Owen J. Roberts all urge the retention of the classics in the college course.

Samuel T. Bodine says he is frank to admit that so far as his life work has been concerned, it would have been much more useful to him to have taken a scientific course and substituted modern languages for Latin and Greek.

Wm. McClellan says that if college is to produce a cultural commencement, all study must be for education in the literal sense—a drawing out or development of the individual—with no vocational object whatever. Among the sciences, tongues, and mathematics he says it would be unwise to indicate a preference or attempt an evaluation here.

Joseph Carson says that his father and the fathers of his friends, who graduated from college in the seventies, possessed at our present age a broader pyramid of cultural background than we, of an age between forty and fifty, today possess. Carson knows that he does not possess the culture of his father and his friends of that day. They knew their five or six subjects well. Does the present student know as much of his twenty subjects? Should he? Carson does not know how to answer the question, but he thinks it is a very interesting one. J. H. G.

Better Instruction through an Improved Curriculum. W. M. WILLEY. *High-Sch. Teacher*, **6**, 22–3 (Jan., 1930).—The author presents a brief for the thesis that an "improved curriculum is of more importance than the manner in which it is taught."

As a basis for finding this improved curriculum, the seven cardinal aims of secondary education, practice in our best high schools, expert opinion from our educational leaders, and the interest and sanction of the high-school students themselves would all be appealed to. A tentative curriculum assembled by these aids should be carefully criticized in the light of the "fundamental activities of life" and should then be subjected to the test of actual use under schoolroom conditions. Such a curriculum as is desired could be described by the adjectives: interesting or gripping, flexible, practical, cultural and moral, modern and progressive. The paper includes a helpful bibliography. B. C. H.

For the Science Teacher. M. MEISTER. *Sci. Classroom*, **9**, 6 (Mar., 1930).—Important magazines, leaflets, pamphlets, etc., listed. M. W. G.

The Training of the Chemical Engineer. J. W. HINCHLEY. *Chem. & Ind.*, **48**, 1171–3 (Dec. 6, 1929).—The chemical engineer must have knowledge of physical and chemical theories, reactions, and equilibria, so that he may be able to utilize the results of physical and chemical research in plant operation. He is essentially an engineer, however, and should be thoroughly trained in the fundamentals of that science. It is important that he possess a knowledge of industrial economics and factory management. The period of college training may be divided into two parts: the first being devoted to fundamental science and cultural subjects and extending over a period of three or four years; the second period, of about two years, is devoted to the more technical training in engineering practice, processes, treatment of material, plant and factory design and construction, power, heat, light, and industrial economics. An outline of subjects special to the training of a chemical engineer, as issued by the Institution of Chemical Engineers, is included. E. R. W.

Chemical Engineers' Associateship Examination. ANON. *Chem. Age*, **21**, 566–7

(Dec. 21, 1929).—Reproduction of two of the four sets of questions given in the recent examination for Associate Membership in the Institution of Chemical Engineers.
E. R. W.

KEEPING UP WITH CHEMISTRY

Comparison of Protons and Electrons in the Excitation of X-Rays by Impact. H. A. BARTON. *J. Frank. Inst.*, **209**, 1–19 (Jan., 1930).—"The experimental investigation of the laws governing the excitation of X-rays by electron impact appears to be near completion. However, the existence of the proton, with its mass of 1846 times that of the electron, provides the possibility of introducing a new variable—the mass—into collision experiments. Previous investigations have led to inconclusive results except that it is known that when fast alpha particles fall on an element, its characteristic X-ray spectrum is excited.

In the writer's experiments, a mass spectograph is used to bring either protons or electrons, of same energy in range from 15 kv. to 25 kv., onto a copper target. The arrangement eliminates several known sources of error. X-radiation produced was passed into an argon-filled Geiger counter. The procedure was to compare two currents: (1) the current composing an electron beam just intense enough to produce detectable X-rays; and (2) that composing the strongest proton beam which certainly produced less radiation. The ratio of these currents is the minimum value for p, the ratio of the efficiencies for excitation of electrons and protons, respectively.

The results were that (1) no radiation from proton impacts was observed, (2) the minimum value of p from three sets of experiment was 740; 237,000; and 6400. In view of the directness of the experiments, the order of magnitude of the highest figure is presented as the result; *i. e.*, p equals 10^5. This may be compared with $(M/m) = 1846$, $(M/m)^{3/2} = 79{,}310$, $(M/m)^2 = 3{,}408{,}000$.

Wave mechanical considerations of impact processes indicate that radiation should be produced by proton impacts of energy greater than the critical energy (for copper, 8.86 kv.) but intensity formulas have not been derived. If they can be derived the present results offer the possibility of checking the wave mechanics of impact processes."
J. H. G.

A Study of Barium-Tin Alloys. K. W. RAY AND RALPH G. THOMPSON. *Metals & Alloys*, **1**, 314–6 (Jan., 1930).—The alloys were prepared electrolytically from fused bath of 30% potassium chloride and 70% barium chloride. Molten tin served as the cathode and a carbon anode was used, which extended into the fused salts. Cooling curves were recorded by a Brown recording pyrometer. The hardness was determined by Rockwell and Shore Scleroscope. Tables and graphs show the variation of hardness and density with composition of the alloy in respect to the per cent of barium. Results show two intermetallic compounds are formed—$BaSn_3$ and $BaSn_5$. Addition of barium increases hardness and brittleness, rate of corrosion, and decrease of the specific gravity of the alloys. R. L. H.

Nickel and Chromium Extend the Field of Application of Iron Casting. F. B. COYLE. *Metals & Alloys*, **1**, 272 (Dec., 1929).—Investigation has demonstrated the applicability of cast iron is extended by addition of alloying elements. The following characteristics are beneficially modified by the addition of nickel and chromium; grain refinement, reduction of chill, machinability, density, resistance to wear, and strength. Tables and graphs are given showing the composition of the different types and grades of casting. R. L. H.

Metals Used in Aircraft Construction. B. STOUGHTON. *Chem. & Ind.*, **48**, 1189–98 (Dec. 13, 1929).—Metallurgical developments have contributed largely to the evolution and improvement of both the heavier-than-air and the lighter-than-air aircraft. The present tendency is to make all aircraft 100% metal, because of less fire hazard, greater strength-weight factor, and ductility. Extensive tables are included in the article showing the analyses and physical properties of different alloys used in aircraft construction.
E. R. W.

Metals Used in Aircraft Construction. B. STOUGHTON. *Metals & Alloys*, **1**, 317 (Jan., 1930).—Same as article reported directly above. R. L. H.

Light Alloys. Z. JEFFERIES. *Metals & Alloys*, **1**, 267–71 (Dec., 1929).—A discussion of aluminum alloys, their use and physical properties, including tables of physical properties. The magnesium alloys are similarly discussed. R. L. H.

Protecting Aluminum and Its Alloys from Corrosion. ANON. *Chem. Age* (*Mo. Met. Sect.*), **21**, 39–40 (Dec. 7, 1929).—This paper contains brief discussions of different methods for the protection of the surfaces of aluminum and its alloys from corrosion. Among those mentioned are: anodic oxidation followed by applications of paint, enamel,

or a grease; formation of a protective film by immersion in a solution of suitable salts; protective metal films of pure aluminum, cadmium, zinc, or nickel. E. R. W.

Melting, Mechanical Working, and Some Physical Properties of Rhodium. W. H. SWANGER. *Metals & Alloys*, **1**, 263–7 (Dec., 1929).—The use of rhodium metal is limited almost entirely to thermocouples due to its scarcity. In 1927 only 4369 ounces of rhodium was in the hands of the refiners as compared to 88,000 ounces of platinum. The rhodium was purified by forming the chloride, precipitating lead as sulfide, and finally precipitating the rhodium as ammonium rhodium nitrite. The reduction was made by igniting the rhodium chloride in air and later in hydrogen which made a metallic sponge. The rhodium sponge was melted into buttons of the solid metal by use of the oxy-hydrogen flame and the high frequency induction furnace. The buttons thus prepared were used to determine the physical properties of the metal. The properties determined were, forging and swaging, melting point, density, X-ray diffraction data, electrical resistivity, thermal electromotive force, temperature coefficient of electrical resistance, thermal expansion, reflecting power, and hardness. R. L. H.

Recent Developments in the Metallurgy of Cast Iron. R. MOLDENKE. *Metals & Alloys*, **1**, 327–8 (Jan., 1930).—Cast iron under ordinary conditions of super-heating has the ability of holding minute particles of graphite in suspension, which form nuclei for the subsequent growth of large graphite crystals as the molten metal freezes. If the metal be given additional heat to a temperature of 2800 to 3000 degrees F. the suspended particles will all be dissolved, and upon solidification the graphite precipitates out in very fine form. This greatly increases the strength and other physical properties of the casting. R. L. H.

Recent Developments in American Chemical Industry. R. T. BALDWIN. *Can. Chem. Met.*, **14**, 22–8 (Jan., 1930).—The term "chemical industry" is a loose one, as for instance the classification of rayon is "textile" because the end-product is spun and woven, even though the product is derived by a process largely chemical. The author discusses the organization of chemical industry, the obscurity of industrial chemical literature, and includes a brief discussion of the following chemical industries; acetone, ammonia, solid carbon dioxide, cellulose, cellulose food containers and wrappers, diphenyl, dyestuffs, methyl and ethyl alcohols, phenol, slimes in paper mills, solvents, synthetic resins, and water. R. L. H.

The Chemical Kaleidoscope for 1929. *Ind. Eng. Chem.*, **22**, 4–10 (Jan., 1930).—The most important developments are listed under various titles: (1) *The International Chemical Situation*, noting the formation of the international dye cartel, with the exclusion of the U. S., which has one-fourth of the total production capacity; the taking over of patents by Standard Oil of N. J. covering the hydrogenation of coal and oil; the formation of a sales agreement among foreign fixed nitrogen companies. (2) *American Mergers and Agreements*, listing some of the larger mergers. (3) *Industrial Chemistry and Chemical Engineering*, pointing out developments in H_2SO_4 manufacture due to improved vanadium catalysts, reduction in the cost of helium production to $14.01 per thousand feet. Even though gasoline is fairly cheap, buses in actual use are trying out the use of fuel oil in place of gasoline. Synthetic sodium nitrate produced at Hopewell is competing successfully with Chilean nitrate. Potash on a large scale is being produced at Searles Lake. Commercial production of bromine from sea water seems probable, and the new process of manufacturing anhydrous $AlCl_3$ cheaply, gives renewed interest to the Friedel-Crafts reaction. It is predicted that diphenyl, which is now available commercially, will be the source of many new dyes and solvents. In refrigeration CO_2 and silica gel offer interesting possibilities. Progress is made in the production of new alloys, and the development of improved types of chemical engineering equipment. (4) *Chemistry and Human Life*. The outstanding achievements were the isolation of a toxic sugar produced by the tubercle bacillus, and the synthesis of the respiration ferment. The Cleveland disaster was a forcible reminder that nitro-cellulose should be treated with respect. As a result of deaths caused by leakage from refrigeration systems, the Bureau of Mines has conducted an investigation on the toxicity of certain household refrigerants, a report of which is given in *Public Health Bulletin* **185**. The suitability of ethyocaine borate for local anesthesia was demonstrated, ethylene oxide serves as an excellent fumigant for certain insect pests, and the sodium salt of malic acid may be substituted for NaCl in the diet of people suffering from high blood pressure, dropsy, or Bright's disease. Other headings are (5) *Some Important Patent Decisions and Court Actions*, (6) *Trade Associations and Coöperative Groups*, (7) *International Meetings*, (8) *New Research Laboratories*, (9) *The American Chemical Society*, (10) *Medal Awards*. D. C. L.

In Nineteen Twenty-Nine. EDIT. *Am. J. Pharmacy*, **102**, 1–8 (Jan., 1930).—

Some of the most important and most interesting advances in the fields of science during 1929, as included in a copyrighted article by *Science Service*. G. O.

Electrical Industrial Research during 1929. J. LISTON. *Gen. Elec. Rev.*, **33,** 37–9 (Jan., 1930).—A new thermocouple of tungsten and carbon has been perfected which measures temperature directly over a range of 500 to 2400°C. The device increases the range of automatic temperature control about 800°.

Lightning research made possible by the million volt generator, cathode ray oscillographs, surge voltage recorders, and lightning stroke recorders is enabling engineers to understand the demands made of high tension lines under actual conditions of service.

An improvement on the film phonograph permits the recording of 13 sound tracks on a single film, 400 ft. of which will contain a program of two hours' duration. The film is made continuous and arranged so that the shift from one sound track to the next is made automatically.

The cathode ray tube has made possible the differentiation of natural from synthetic sapphires. The sapphire has come into demand by virtue of its use as the jewel used in bearings in electrical instruments. All varieties but one of natural sapphires glow when exposed to the rays in a dark room. The synthetic continue to glow after the light is shut off, while the natural do not. [See "Where Chemical Analyses Fail," by G. Bartlett, THIS JOURNAL, **7,** 399–402 (Feb., 1930).]

A new process for fusing quartz makes possible the production of plates $7^1/_2 \times 7^1/_2 \times {}^1/_4$" which require only squaring and polishing. Crystals are crushed to $^1/_4$" mesh, placed on thin graphite disks in the form of a square, the whole placed between graphite slabs, and fused in a vacuum oven. When fused, nitrogen is admitted to a pressure of 150 lb. per sq. in. to compress bubbles. H. T. B.

The Canadian Gypsum Industry. *Can. Chem. Met.*, **13,** 295–9 (Nov., 1929).—Canada ranks third in gypsum production, which is one of the oldest industries of the country. Large quantities of crude gypsum is shipped into the United States and in turn receives the finished product. The larger producers of gypsum are controlled by American capital. Tables and graphs show the progress of the industry in the different provinces, with a discussion of the industry in each province. R. L. H.

Oxygen and Hydrogen in Industry. W. P. DOBSON AND A. S. L. BARNES. *Can. Chem. Met.*, **13,** 292–4 (Nov., 1929).—The annual world consumption of relatively pure oxygen is about 5.5 billion cu. ft. and of pure or relatively pure hydrogen about 100 billion cu. ft. The use of oxygen is not centralized and distribution is a large factor in the high cost of pure oxygen. There is a possibility for a centralized use of oxygen in the enrichment of air supplied to blast furnaces, which would greatly increase the efficiency of the plant process. Hydrogen has a wider use in the manufacture of synthetic ammonia, hydrogenation of coal, and electrolytic hydrogen for hardening of fats. Another possible use of hydrogen is in the reduction of ores. There are several places in the United States and Canada where water power is available for the production of electrolytic hydrogen and oxygen. Usually, however, only one of the gases, which are both in a high state of purity, is desired. This introduces the problem of disposing of the unused gas as a by-product, which in any case may be practically impossible. R. L. H.

Some New Aspects of the Electrochemical Oxidation of Organic and Inorganic Compounds. Part 4. Kolbe's Synthesis of Hydrocarbons. Part 5. The Action of Fluorine on Inorganic and Organic Compounds. F. FICHTER. *Chem. and Ind.*, **48,** 347T–58T (Nov. 29, 1929). E. R. W.

Printing Inks. ANON. *Chem. Age*, **21,** 526 (Dec. 7, 1929).—A review of a paper read by T. Hedley Barry dealing with the history and development of printing inks. E. R. W.

The Zeolite Process of Water Softening. ANON. *Chem. Age*, **21,** 502–3 (Nov. 30, 1929).—Summary of existing knowledge of the base exchange or zeolite process for softening water. The zeolite process has many advantages over the older lime-soda process but it cannot be used to advantage with waters which are turbid, ferruginous, or acid. For many waters a preliminary lime-soda treatment followed by a base-exchange process is found to be most satisfactory. E. R. W.

Types of Filtration Plant and Materials. ANON. *Chem. Age*, **21,** 493–500 (Nov. 30, 1929).—Illustrations and brief discussions of many types of industrial filters, including slime filtration, sand filters, rotary filters, vacuum filters, filter presses, metal mesh filters. Suggestive diagrams of several forms of sintered glass laboratory filters are included. E. R. W.

The Science and Practice of Filtration. ANON. *Chem. Age*, **21,** 489–93 (Nov. 30, 1929).—An account of the general scope and principles of modern industrial filtration, giving something of its importance in our lives. E. R. W.

$67,527.00 per Year Less for Filtering. ANON. *Inco*, **9**, No. 9 (1930).—It is not usual to think of a metal when the process of filtering is mentioned. But the Pennsylvania Sugar Company at Philadelphia has learned to its financial advantage that Monel Metal mesh can be used as a filter and successfully substituted for canvas cloth. By such installation the filtering cost per thousand pounds of sugar was reduced from $0.188 to a price varying between $0.106 and $0.082. Considering the capacity of the factory, the annual saving is as captioned above. This saving is largely upon decreased labor costs, longer life of the equipment, and lessened cost of upkeep. B. C. H.

Microchemical Behavior of the Official Alkaloids. L. ROSENTHALER. *J. Am. Pharmacy*, **101**, 821–9 (Dec., 1929).—A communication from the Pharmaceutical Institute of the University of Berne. During the war the author wrote an article at the front entitled "Pharmacopœia and Economy" to show the value of microchemistry. Again the writer is trying to convince the scientist that there is an enormous amount of waste in macrochemical methods, the pharmacopeias containing more test reactions than are absolutely necessary. He is criticizing the German Pharmacopœia, 6th edition, particularly, which omits microchemical reactions entirely for qualitative testing of drugs. He concludes the article with a group of tests to show the microchemical behavior of alkaloids, a field in which the superiority of the microchemical tests is particularly obvious due to the high cost of these substances. G. O.

Experiments with Extracts from the Woolly-Pod Milkweed (*Asclepias eriocarpa*). J. F. COUCH. *Am. J. Pharmacy*, **101**, 815–21 (Dec., 1929).—The woolly-pod milkweed, *Asclepias eriocarpa*, has been recognized as a poisonous plant. No reported chemical examination of it, however, had been made until this study. The material used was collected in Fresno County, Calif. The toxic constituent was completely extracted by hot water and the fractionated water extract administered to guinea pigs and sheep. Certain definite results were obtained which are reported in this article; namely, the woolly-pod milkweed (*Asclepias eriocarpa*), a dangerously poisonous plant containing a single toxic constituent which is a complex organic acid, insoluble in water, acids, chloroform, and ether; soluble in aqueous alkalies and in alcohol; non-glucosidal, non-hemolytic, does not contain basic nitrogen, and may be dialyzed. It has been obtained sufficiently pure to permit certain of its properties to be determined. The physical and chemical properties of the substance distinguish it sharply from the poisonous substances of *Asclepias gliodes*, a resinous substance of the picrotoxin group, insoluble in aqueous alkalies and very soluble in organic solvents with the exception of petroleum ether. The minor toxic constituents of this plant are glucosides, and they are moderately soluble in water. G. O.

The Chemical Diagnosis of Nitrogen Starvation in Growing Crops. J. B. SMITH. *Rep. New Eng. Assoc. Chem. Teachers*, **31**, 72–4 (Jan., 1930).—A study was made of the nitrates in plant sap in an effort to discover nitrogen shortages before growth depression makes them observable to the eye. Samples of leaves were frozen by solid carbon dioxide after which the solution was expressed in a small hydraulic press at a pressure of 1200–1300 lb. per sq. in. O. C.

The Story of Oxygen. ANON. *Tycos*, **20**, 35 (Jan., 1930).—In antiquity and through the middle ages, air was thought to be a single substance. In the middle of the eighteenth century, carbon dioxide was discovered. Then the discovery of nitrogen, later, oxygen and the phlogiston theory which was exploded by the father of modern chemistry—Lavoisier. Today we know oxygen to comprise nearly half of terrestrial matter; we must use vast amounts of the isolated gas in industrial operations. We have studied oxygen in the atmosphere and believe it to occur in a diatomic state in the lower strata, as triatomic in the upper strata, and probably monoatomic in the strata in which the auroral discharges occur. The latter condition may be responsible for the much discussed green-line in the auroral spectrum. H. T. B.

The Carbon Oxide Brothers, Mon and Di. F. P. STROUP. *Am. J. Pharmacy*, **102**, 22–38 (Jan., 1930).—One of a series of popular science lectures given at the Philadelphia College of Pharmacy and Science, 1929. An article presenting both the favorable and unfavorable sides of the respective characters of these two members of the chemical family. Particularly good are the illustrations of carbon dioxide poisoning and incidents emphasizing the dangerous character of carbon monoxide. G. O.

On the Scent—Perfumes. B. THORNLEY. *Collier's* (Dec. 21, 1929).—The story of how Prince Matchabelli, whose perfumes won the Grand Prix in France, Belgium, and Italy last year, became interested in perfumes. The following salient facts were brought out as the result of an interview with the Prince. The U. S. spent between forty and fifty million dollars last year on perfumes. Fancies in perfumes have always varied from year to year, the present trend being toward a light but lasting fragrance which

must be subtle, complex, and unforgettable. In making a perfume it is necessary to consider not only the chemistry of the perfume but the physical chemistry of the women who will use it. The same perfume put on the wrists of six different women may give six different effects. The best test of a perfume is to put it on the skin and let the alcohol evaporate.

Flower oils are used less and less. Fifty to sixty per cent are synthetic. Some vegetable oils are used. J. W. H.

The Story of the Coconut. H. DE LEEUW. *Pract. Home Ec.*, Oct., **1929.**—There are thirty varieties of coconuts, five being commercially important. They grow best where the temperature is from 75 to 80° F., and there is lots of sunshine.

The *oil* is used for nut butter, soap, candles, lubricant, luminant, and cosmetics. The *husk* is used for rope, mats, mattresses, fuel, brushes, okum, and candles. The *nut* itself is a food; the residue after removal of oil, being rich in albuminoids, oil, and carbohydrates, makes good cattle feed. The *shells* are made into dippers, bowls, handles, fish hooks, spoons, gourds, linoleum, and cups for tapping rubber trees. The *bark* of the tree yields a cohesive gum; *stems* are made into furniture and *husks*, being rich in potassium and phosphorus, are good fertilizer. The *leaves* make roofing, mats, baskets, and fodder. The *milk* is a good drink and the *pits* of the unripe fruit yield an oil. J. W. H.

Romance of the Machine. M. PUPIN. *Scribner's*, **87,** 130–7 (Feb., 1930).—A notable and brilliant defense of the machine in modern life and the part it has played in the progress of civilization. It is not a sign of sordid materialism but "the machine is the visible evidence of the close union between man and the spirit of eternal truth which guides the subtle hand of nature." F. B. D.

SCIENTIFIC REVIEWS AND BIBLIOGRAPHIES

Fifty Years of Physical Metallurgy. .H. M. BOYLSTON. *Metals & Alloys*, **1,** 329–31 (Jan., 1930).—The author defines physical metallurgy, discusses its early history, the early developments of metallographic equipment, steel hardening theories, crystalline growth in metals, Neumann bands, and the iron-carbon diagram. An exhaustive list of references is given. R. L. H.

The Systems of Rutherford-Bohr. U. CRUDELI. *Nuovo cimento*, **6,** 243–8 (1929); *Chem. Abstr.*, **24,** 293 (Jan. 20, 1930).—A review of the generalizations of Rutherford-Bohr with particular reference to triangular (three body) systems and a discussion of Crudeli's extension of these theories (*cf. Chem. Abstr.*, **22,** 4352). C. E. M.

HISTORICAL AND BIOGRAPHICAL

Wilhelm Ostwald, Winner of the Nobel Prize in 1909. *Chem.-Ztg.*, **33,** 1289 (Dec. 11, 1909).—Nobel prize granted in recognition of his works on catalysis, as well as for his investigations into the fundamental principles governing chemical equilibrium and rates of reaction. M. W. G.

Wilhelm Ostwald. *Chem.-Ztg.*, **37,** 1051 (Sept. 2, 1913); **47,** 736 (Sept. 7, 1928); **52,** 690 (Sept. 1, 1928).—Ostwald was born on September 2, 1853. These references contain notes on Ostwald and his work, written on the occasions of his 60th, 70th, and 75th birthdays. M. W. G.

Wilhelm Ostwald. *Umschau*, **26,** 701–3 (1922).—Biographical with portrait. M. W. G.

Wilhelm Ostwald. See Moore's "History of Chemistry," McGraw-Hill Book Co., Inc., New York, **1928,** pp. 247–8 for biographical note. See index of Harrow's "Eminent Chemists of Our Time," D. Van Nostrand Co., Inc., New York City, **1927,** for scattered references to Ostwald's work. For an account of some of Ostwald's scientific work, see index of Muir's "History of Chemical Theories and Laws," John Wiley & Sons, New York City, **1906.** M. W. G.

The Work of Wilhelm Ostwald in Inaugurating the New Era in Chemistry. H. C. JONES. "New Era in Chemistry," D. Van Nostrand Co., New York City, **1913,** pp. 172–214. M. W. G.

William McPherson. B. T. BROOKS. *Ind. Eng. Chem.*, **22,** 100 (Jan., 1930). D. C. L.

Edwin Emery Slosson. R. D. O'LEARY. *Graduate Mag., Univ. of Kansas*, **28,** 6–7 (Nov., 1929).—An appreciation of Slosson. Portrait. F. B. D.

Obituary—Samuel Rideal. H. F. MORLEY. *Analyst*, **55,** 2–5 (Jan., 1930).—Samuel Rideal, son of the late John Rideal of Sydenham, was born at Brixton in 1863. He obtained a scholarship at Dulwich College, where he was a pupil from 1875 to 1878. Through his associations at the meetings of University College Chemical and Physical Society he transferred his studies to University College, London. In 1883 during the professorship of A. W. Williamson he became assistant in the Chemical

Laboratories, which post he held for several years, including a period of time during the professorship of Sir William Ramsay, until in 1889 he became lecturer on chemistry at St. George's Hospital Medical School. He took his B.S. degree in 1884 at the University of London, with first-class honors in chemistry, and in 1886 obtained his Doctor of Science Degree at the University of London. He married Lilla, daughter of Samuel Keightley, by whom he had three sons and one daughter. Rideal made many contributions to the literature, of which "A New Volumetric Method for the Estimation of Nitrous Acid," "Action of Ammonia on Chromyl Dichloride," and "Organic Boron Compounds" are some of the important ones. The following are some of his books published; "Practical Organic Chemistry for Medical Students," "An Introduction to the Study of Disinfection and Disinfectants," "Water and Its Purification," "Sewage and the Bacterial Purification of Sewage," "Public Water Supplies," and "The Carbohydrates and Alcohols." His friends had been anxious of late years about his health. A visit to South Africa failed to restore his health, for he died suddenly at Hartley in Southern Rhodesia, Nov. 13, 1929. R. L. H.

Charles Moureu. G. URBAIN. *Ann. chim.*, **12,** 3–8 (1929); *Chem. Abstr.*, **24,** 273 (Jan. 20, 1930).—Obituary with portrait. C. E. M.

Richard Lorenz. A. MAGNUS. *Z. Electrochem.*, **35,** 815–22 (1929); *Chem. Abstr.*, **24,** 273 (Jan. 20, 1930).—Obituary including bibliography. C. E. M.

Raphael Edward Liesegang. *Kolloid-Z.*, **49,** 225–9 (1929); *Chem. Abstr.*, **24,** 273 (Jan. 20, 1930).—Autobiography with portrait. C. E. M.

Louis Pasteur. H. W. WILEY. *J. Assoc. Official Agr. Chem.*, **12,** 370–7 (1929); *Chem. Abstr.*, **24,** 451 (Jan. 20, 1930).—An address outlining Pasteur's achievement in the field of agricultural chemistry. C. E. M.

Peter Shaw, M.D., Apostle of Modern Chemistry. O. E. MAY. *Hexagon*, **20,** 204–7 (Jan., 1930).—Shaw was a physician, chemist, pharmacist, and philosopher. His writings were among the primary causes for the development of chemistry in England. Shaw was born in 1694, but little is known of his early life. In 1723 he published his "Course of Lectures in Pharmacy," and in 1725 his "Works of Boyle." Shaw was ever in demand as lecturer on scientific subjects, and original writings and translations flowed from his study in a steady stream. He practiced medicine and contributed regularly to the medical literature. Many publications followed on chemistry and philosophy. In 1752 he was appointed physician extraordinary to King George II, and was created an M.D. at Cambridge by royal mandate. In 1854 he was promoted to be physician in ordinary to the king, and was elected a fellow to the College of Physicians. Shaw died on March 15, 1763, and was buried in the nave of Wimbledon Church.

Shaw was a firm believer in "putting all phenomena to test" before accepting them. He compiled one of our first tables of solubilities. "His chief contribution to chemistry may well have been his undoubted success in stimulating interest in the science in English-speaking countries." R. L. H.

Scientific Centenaries in 1930. *Nature*, **125,** 21–2 (Jan. 4, 1930).—Centenaries in all branches of science are included in this list. Those of interest to chemists are: (1) Kunckel (1630–1703), the German chemist who assisted in emancipating the literature of chemistry from the mysticism of alchemy; (2) Raoult (1830–1901), recipient of the Davy Medal in 1892; (3) Bemmelen (1830–1911), who contributed to the founding of the Dutch School of physical chemistry; (4) Lothar Meyer (1830–95), best known for the share he had in the periodic classification of the elements, and whose memorial lecture before the Chemical Society was delivered by Prof. Bedson in 1896; (5) Richard Chenevix (1774–1830), the Irish chemist and mineralogist, once the recipient of the Copley medal. C. E. M.

Solders Used by the Goldsmiths of Ur. E. A. SMITH. *Discovery*, **11,** 20–3 (Jan., 1930).—The author, having examined some of the gold objects recently discovered in Mesopotamia, is able to reveal new details of the soldering methods employed six thousand years ago. The remarkable knowledge of the ancient craftsmen becomes clear from comparison with present-day practice. The successful excavations at Ur of the Chaldees, made recently by Mr. Woolley, have brought to light many beautiful examples of ancient goldsmiths' work, which clearly showed the high degree of technical manipulation attained over five thousand years ago.

From analyses of the beads of necklaces, beakers, rings, etc., it seems that gold of about 18 carats was used. From the analyses, there is no indication of the source of the gold; but it is surmised that the gold used was a general melt of scraps from various sources, even including the solders. Borax, the universal flux of the goldsmiths, was known to the Egyptians, and Schlieman states that it was used by Mycenean goldsmiths for soldering gold. There are three distinct methods for joining gold. (1) Fusion or

sweating in which the pieces are joined by the local fusion of the surfaces when close in contact. (2) Soldering with the aid of a solder consisting of a piece of the same metal as that composing the object to be soldered. (3) Soldering with the aid of alloys (*i. e.*, gold and silver) having a lower melting point than that of the metals to be joined. It is the opinion of the author that all three methods were used at Ur. It appears also that the ancients were familiar with the use of silver and copper to modify the color of gold, and with the fact that the presence of large quantities of copper made more difficult the operation of soldering. J. H. G.

New Light on Ancient Ur. M. E. L. MALLOWAN. *Natl. Geog. Mag.*, **57,** 94–130 (Jan., 1930).—An account of recent archeological discoveries, with many illustrations, a number of which are of interest in connection with the article covered by the foregoing abstract, **Solders Used by the Goldsmiths of Ur.** M. A. C.

So Simple a Device as the Thermometer. EDIT. *Am. J. Pharmacy*, **101,** 803–5 (Dec., 1929).—Traces the evolution of the thermometer from Galileo (1593) to the present short one which has existed since 1867 with no radical change in the instrument since Clifford Allbutt devised it. Aikins' thermometers (1865–1867) were 10 inches long, taking 5 minutes to record the temperature. G. O.

The History of Alcohol and the Term Gas. E. O. VON LIPPMANN. *Chem.-Ztg.*, **53,** 869–70 (Nov. 9, 1929).—A historical review and references to the literature. L. S.

History of the Department of Chemistry, University of Tennessee. C. O. HILL. *Hexagon*, **20,** 195–7 (Jan., 1930).—The first instructor of chemistry in the University of Tennessee was Joseph Estabrook who introduced the subject in the junior and part of the senior year in 1837. In 1870 the department was reorganized by Dr. W. O. Atwater, later head of the food investigation of U. S. Department of Agriculture. In 1873 Dr. Atwater was succeeded by Dr. W. A. Noyes, later head of the department of chemistry at University of Illinois. Dr. Noyes was replaced by Dr. Chas. W. Dabney in 1886 who brought Dr. Chas. E. Wait as professor of general and analytical chemistry. In 1892 a four-story science building was completed, one floor of which was occupied by the department of chemistry. In 1917 Dr. Chas. O. Hill, who is now head of the department of chemistry, became professor of general chemistry. The enrolment in the department since 1898 has increased from 80 to 800 students, and the department has extended over the entire building, including a new unit. R. L. H.

EDUCATIONAL MEASUREMENTS AND DATA

A Study of High-School Chemistry Contests. S. W. HETHERINGTON. *Rep. New Eng. Assoc. Chem. Teachers*, **31,** 86–93 (Jan., 1930).—A discussion of the Rhode Island State College Chemistry contests under four headings. (1) The more important historical and statistical features. (2) The analysis of the 1929 contest as to form of type. (3) Examples of questions answered (*a*) exceptionally well, (*b*) uniformly incorrectly. (4) Criticisms of the tests. O. C.

Construction Activities in Improving Instruction in Eighty-Seven Institutions. F. W. REEVES. *North Cent. Assoc. Quart.*, **4,** 371–6 (Dec., 1929).—Included among the institutions studied by means of personal visits, are 49 privately endowed colleges, 12 privately controlled junior colleges, 12 state teachers colleges and normal schools, 4 state universities, 2 state-controlled junior colleges, and 8 colleges for colored students. The administrative procedures noted most frequently for improving instruction were: (*a*) classroom inspection and supervision of instruction, (*b*) administrative devices for individualizing instruction, (*c*) studies of the classification of students, student load, and duplication in the content of the courses, (*d*) orientation courses, (*e*) ability grouping. Relatively few schools are attempting supervision of instruction. The device most frequently employed in individualizing instruction is some form of the so-called "honors-course." Approximately one-fifth of the schools studied are using this device in junior and senior courses in some or in all departments. Many schools are making studies in the classification of students, student load, and content of courses. In 22 institutions studied, student load ranged from 20 hours to 70 hours with an average of 42 hours spent upon school work per week. In three schools where students rated their instructors, the instructors obtaining most work from their students were rated as the better instructors; about 60 per cent of the schools offer some type of a survey or orientation course. Many schools are conducting experiments in teaching method such as objective testing, individualized instruction, diagnosis and remedial work and lectures, forums and higher education courses for faculty members. Purdue University has been carrying on a notable experiment in supervision of the study of freshman. Four colleges under the direction of Professor Virgil Payne of the chemistry department of Transylvania College are conducting an experiment with the lecture-demonstration method as a

substitute for the laboratory method in first-year college chemistry. Six paired sections were used. Results of the experiment showed that the best group of the six was the only one which seemed to profit more from beginning elementary chemistry with individual laboratory work. Two conclusions from this study are: (1) it is unwise to require individual laboratory work of all beginning students in chemistry; and (2) students of lesser aptitude in chemistry profit more by observing teacher experimentation preceding individual laboratory work than by beginning laboratory work without such observation. C. M. P.

A Study of Vocational Interests of California High-School Students Based on a Survey of Twelve Rural High Schools. J. H. BEDFORD. *Calif. Quart. Sec. Educ.*, **5**, 47–66 (Oct., 1929).—This is the second part of the report. It was found that the choice of a vocation in most cases is governed mainly by tradition and sentiment. Dominant vocational interests of the community and the occupation of the father do not seem to influence the vocational choices of the pupils to any great extent. The best liked subject in school, the favorite recreation, and previous occupational training or experience are all rather definitely related to the vocational choice. The most popular groups of subjects in the schools studied were, in order of rank: practical arts, laboratory science, language, mathematics, and social sciences. Pronounced sex differences were found in subject-matter interests.

Subject-Matter Interests of 1211 High-School Students

Subject	Like most	Dislike most	Like most	Dislike most
	Boys		Girls	
Agriculture	19	1		
Algebra	25	49	27	62
Arithmetic	9	3	6	20
Art	9	3	21	1
Aviation	2			
Biology	16	11	13	18
Bookkeeping	15	5	30	7
Business Training	10	4	8	2
Chemistry	17	11	5	12
Citizenship	4	18	5	15
Commerce		1	4	
Cooking			3	
Economics	8	7	2	7
English	71	151	170	46
French			4	
Geography		1	3	4
Geometry	13	23	9	28
History	81	49	46	121
Household Arts			10	
Latin	3	21	22	11
Mathematics	51	19	11	37
Mechanical Drawing	40			
Music	3		13	
Physics	7	3	2	2
Physical Education	3	1	1	5
Public Speaking	7	3	5	6
Sewing			30	10
Science	53	17	21	5
Shop	66	5		
Stenography	1	2	25	8
Spanish	25	49	50	42
Typewriting	12	3	54	8
Vocational Guid.	2			1

C. M. P.

Replacement Value of Science Equipment. V. O. WORKMAN. *North Cent. Assoc. Quart.*, **4**, 349–51 (Dec., 1929).—This is the resumé of a study of the replacement value of science equipment in 47 colleges and universities, 33 junior colleges, and 49 teachers colleges for the year 1926–27.

Colleges and Universities

		Greatest	Mean
1.	Total replacement value	$803.26	$ 9.42
2.	Chemistry	178.57	25.71
3.	Physics	270.10	18.95
4.	Biology	212.22	21.38
5.	Home economics	96.46	8.87
6.	Geology	103.48	9.89
7.	Botany	43.17	11.21
8.	Psychology	12.63	3.21
9.	Zoölogy	26.61	9.15
10.	Engineering	60.79	27.75
11.	Astronomy	37.86	10.01
12.	Bacteriology	17.53	5.21

Junior Colleges

1.	Total replacement value	$313.67	$73.68
2.	Chemistry	92.80	28.03
3.	Physics	138.12	33.35
4.	Biology	82.73	21.04

Teachers Colleges

1.	Total replacement value	$134.62	$29.43
2.	Chemistry	32.05	8.98
3.	Physics	24.16	7.83
4.	Biology	35.36	7.70
5.	Home economics	32.05	8.39
6.	Agriculture	19.11	5.19

C. M. P.

A Comparative Study of Standardizing Agencies. W. A. COOK. *North Cent. Assoc. Quart.*, **4**, 377–455 (Dec., 1929).—This comparative study is quite complete. Standardizing agencies for both secondary schools and colleges are included. The standardizing agencies studied are: (1) Association of Colleges and Secondary Schools of the Middle States and Maryland, (2) North Central Association of Colleges and Secondary Schools, (3) Association of Colleges and Secondary Schools of the Southern States, (4) New England Association of Colleges and Preparatory Schools, and (5) Northwest Association of Secondary and Higher Schools. C. M. P.

Research Activities in California School Departments. F. C. TOUTON. *Calif. Quart. Sec. Educ.*, **5**, 5–36 (Oct., 1929).—This is the report of the committee on Educational Research Activities. The report includes the names of the cities conducting the research, the title of the research, the person responsible, and something of the nature and findings of the research. C. M. P.

Homogeneous Grouping. K. O. BROADY. *High-Sch. Teacher*, **6**, 16–9 (Jan., 1930).—This study is something of a summarization of a series of visits paid by the author to some cities of the northeastern section of the United States the spring of 1928. While the data presented may not be quite so exact as that which might have come by questionnaire, it has the compensating advantage of giving "a more complete gaging of intent and motivating purpose" than possible from the formal communication.

A review of studies previously made in this field prompts the statement, "It is clear that evidence available as to the advisability of grouping is hardly conclusive."

He found, however, that, with two exceptions, the twelve cities visited were favorably disposed toward ability grouping in secondary schools. One of these two was suffering from a previous ill-advised administration of such a grouping.

Of the criteria used for such grouping, intelligence quotients are used by all to some extent, chronological age is the next most frequent aid, then follow: teachers' judgment, achievement ratings, language difficulties, reading ability, index of brightness, etc. The author especially commends the use of the phrase "probable learning rate" as a substitute for the less tactful "intelligence quotient." In doing this he recognizes that "ability grouping brings with it the danger of unduly vaunting the pride of certain parents and of hurting the sensibilities of others."

It is quite generally agreed that content and method should be adapted to ability levels if such grouping is to attain its maximum possibilities. In the later years of the senior high school, purpose grouping may well be recognized as an aid to ability grouping.

B. C. H.

Evident Limitations of Intelligence Tests. H. N. GLICK. *Sch. Exec. Mag.*, **49**, 294 (Jan., 1930).—Our present measuring instruments of intelligence are open to much criticism because they would rank many successful people as unintelligent and others in the highest ranks of the so-called intelligentsia are apparent failures.

One trouble is our varying definitions of intelligence, which vary from the too narrow "conscious adaptation of thinking to new situations" to the too broad "ability to render social service." Intelligence viewed as it should be is not a general thing but is composed of a great many specific characteristics or factors more or less independent of each other and they should all be considered in a proper test. J. W. H.

THE PHILOSOPHY OF EDUCATION

The Graduate and His Work. R. I. REES. *J. Eng. Educ.*, **20**, 231–71 (Nov., 1929).—A symposium in which the first two papers discuss these four main topics: (1) Orientation of the student as to what a career in industry means to him. (2) Some treatment of the employment procedure by which a student secures his position. (3) His placement in industry and his adjustment to his industrial environment. (4) Those factors of success on the job which have a direct bearing upon the training that he has received during his undergraduate work.

Representatives from industrial companies try to do two things in their interviews with students: (*a*) to help the student determine where his deepest interest lies, and (*b*) to give him information as to opportunities available in a specific industry. Some companies have a booklet intended for the student to read. Students, as a rule, do not read it; so it is suggested that a booklet be published by a number of industries in common, and that representatives interview men provided that they have read the booklet and have written down a number of facts about themselves. To lessen the burden on faculty members caused by the visits of scouts, it is suggested that a fixed period be designated for such visits, and that the student be allowed ample time to consider as many opportunities as he needs to make up his mind.

Qualities of the student which are considered by every employer are: scholarship, extra-curricular activities, student interests, and environment. The opinion of faculty members as to traits, personality, and general fitness are of value. Men are desired who possess a well-trained mind, sound character, solid integrity, and a thorough knowledge of the fundamentals. They must also be adaptable, adjustable to a certain degree of fixed purpose and yet flexible enough to fit into the program of the company. The star of the class is often undesirable because he is difficult to handle. Representatives find that many men are careless as to their personal appearance, personality, and manners—of which they have none. It is suggested that a school ought not to neglect that phase of a man's training. Schools are teaching boys—not subjects. The problem appears to be one of presenting to the student during his freshman and sophomore years what is expected of him. That is a task to be undertaken by industries, engineers, and schools.

New men are no longer allowed to sink or swim as they will, but are given a course of training varying from a few weeks to months in length. During this time the student acquires a perspective, a broadened acquaintance, undergoes exposure to different people and departments, and is given information. At the same time he is asked to prove himself honest, reliable, industrious, and punctual. He cannot go on his past reputation.

Corporations in writing to schools often ask for men from the upper one-third of their classes, regardless of the standing of the school. The graduates of a college represent the survivors of a weeding-out process of sixteen years' duration, or the upper one-tenth of those that started. If only one-third of these are desirable, then something must be wrong with the system. Industry should study and classify its needs, while at the same time the schools should study their men, in order that the entire group of graduates may be desirable. "Our country is in much greater danger of decay from lack of good citizenship and cultivation of right philosophies of life than from lack of industrial progress. Hence, men should not be expected to work all day and study at night in order to promote the special interests of their company."

Men who are educated for the engineering profession and find themselves to be misfits should be encouraged to change. "The engineering and industrial field offers attractive opportunities for those who have the qualifications, aptitude, and ability for work. Engineering courses also offer the peculiar advantage of offering a basic training for business as well. The expense and time is not wasted even though the student does not follow engineering."

The following "formula of success" is offered to the student: (1) Look over the ground thoroughly and select the industry in which you are most interested. (2) Look

yourself over and decide in which phase of work presented by that industry you would like to be. (3) Take the best job in the best company that comes nearest to meeting the conditions. (4) "Do anything under heaven that anybody in that company gives you to do and do it a little more satisfactorily, a little better than the average." (5) Let the future take care of itself. H. T. B.

Natural Phenomena as a Source of Inspiration in Education. J. C. MERRIAM. *Educ. Record*, **10**, 272–6 (Oct., 1929).—Natural phenomena have been too much neglected as a source of inspiration in education. When not neglected, far too often the methods of approach to the study of natural phenomena have not been the best. The author believes the better method is to lead the student to the thing itself and then to efface one's self from the picture as soon as possible. "Too often the proper way to proceed is considered to be to have models, charts, and diagrams with which we first instruct the visitor and then permit him to go and see the things we have been discussing and interpreting." Nine-tenths of the battle of education is won when interest becomes the motivating principle in learning. C. M. P.

Democracy in Education. J. DEWEY. *J. Natl. Educ. Assoc.*, **18**, 287–90 (Dec., 1929).—An article written by Dewey in 1903. C. E. M.

My Pedagogic Creed. J. DEWEY. *J. Natl. Educ. Assoc.*, **18**, 291–5 (Dec., 1929).—This creed was first published in 1897. A booklet was issued by the Progressive Education Association, Washington, D. C., in connection with the 70th birthday celebration of Dewey. C. E. M.

THE PHILOSOPHY OF SCIENCE

The Diary of a Scientist. H. KNOTT. *Tycos*, **20**, 20 (Jan., 1930).—We may go with the scientist in his diary as he makes his experiments, as he pieces together the results and makes his deductions, which are often of such vast importance to us all. We find him to be a man of truth; he sets down the record of his failures as well as his successes, not in despair, but as a challenge. We may watch the birth of generalizations, coming as the result of long and painstaking work. With Faraday, the reader of his diary may discover the principle upon which the modern dynamo is based, and which has led to so much of luxury and utility for us. What an inspiration it should be to each of us to become acquainted with a man who "alone and single-handed, storms at the silent gates of nature's elusive, yet alluring lands." H. T. B.

PROFESSIONAL

The Economic Status of Scientific Men and Women. I. Budget Needs of College Teachers. B. R. ANDREWS. *Science*, **70**, 19–25 (July 12, 1929); **II. Salaries and Supplementary Earnings of College Teachers.** F. P. BACHMAN. *Ibid.*, pp. 26–9; **III. Salary Scales of Trained Men and Women.** R. H. TRUE. *Ibid.*, 47–56 (July 19, 1929); **IV. Discussion.** H. F. CLARK. *Ibid.*, p. 57. See Digest "On Sixty Dollars a Week" in this issue of the JOURNAL, pages 913. G. H. W.

On Sixty Dollars a Week. *Kalends*, **9**, No. 2, 7–10 (1930).—See same title in Chemical Digest of THIS JOURNAL, page 913. M. W. G.

Insurance for Employees of University of Minnesota. See title of **University of Minnesota** in the *Locals* on page 946.

Educating the Educators. Part II. The In-Service Training of Young College Teachers. A. M. PALMER. *Assoc. Am. Coll. Bull.*, **15**, 443–67 (Dec., 1929). [See THIS JOURNAL **7**, 698 (Mar., 1930).]—At the 15th annual meeting of the Assoc. of American Colleges certain actions were taken with regard to the training of young college instructors in respect to teaching. The full report was published in the March *Bull.*, **1929.** In the fall of 1929 another communication was sent to the membership of the association to ascertain whether any new policies had been adopted. Their reactions are reported in this *Bulletin*. The reported results indicated general concurrence in the aims and ideals of the recommendations although several colleges had not yet formulated definite policies. Faculty meetings, conferences, committees, surveys, educational specialists were some of the methods employed to invite coöperation and consideration of the question. The colleges endorsed most heartily the idea that "teaching power is the fundamental thing rather than research scholarship, valuable as that may seem." Some suggested technics which might be followed in realizing the recommendations of the Association are:

Faculty advisers
Self analysis reports
Classroom visitation
Coöperative courses
Observing older teachers
Lecturing in advanced courses
Inter-department conferences
Intra-sectional coördination
Annual reports of the work of the new instructors.

While the facts presented in this report indicated an appreciation of the Association's contention that "the development of the teaching ability of newly appointed instructors is a major responsibility of the colleges," further observations show that facts do not always bear out the contention that college professors longest in service will be superior to the younger members. The question then arises, is it not a bigger problem to keep the older men fresh and vigorous and successful? Dr. Robt. Kelly [*Assoc. Am. Coll. Bull.*, **15,** 49–67 (Mar., 1929)] uncovered some very significant evidences of colleges trying to develop their faculties by encouraging "in-service study," graduate study and research while in service, sabbatic leave, and summer session work. If the recommendations of the Commission have done nothing else, they have at least stimulated the colleges to think about the problem and to analyze their own situations. G. O.

Qualities of a Successful Teacher. R. C. CLARK. *Education*, **50,** 248–54 (Dec., 1929).—I have mentioned eight qualities which a superintendent is always seeking in a teacher: *moral character*, including reputation; *life*, that is to say a capacity for growth; the *service-complex*—that is, a sinking of self in the desire to accomplish; *and child-mindedness*, which is an understanding of and sympathy with children; *judgment*, which permeates all her activities; *enthusiasm*, which is contagious; and *health*, the requisite of all industrious and productive labor. There are many others which are more than can be numbered, but given these and the others will usually take care of themselves. H. H. K.

CONTEMPORARY NEWS AND COMMENTS IN CHEMISTRY AND EDUCATION

Dedication—Charles James Hall, University of New Hampshire. A. P. SKOOG. *Hexagon*, **20,** 210–1 (Jan., 1930).—On Nov. 9, 1929, a new building was dedicated at the University of New Hampshire. The building is designed to accommodate the departments of chemistry together with the Agriculture Experiment Station.

[*Editor's Note:* For an account of this dedication see pages 812–20 of this issue of the JOURNAL.] R. L. H.

Anniversary Meeting of the Royal Society. *Nature*, **124,** 892–3 (Dec. 7, 1929).—Account of meeting and medal presentations. C. E. M.

Canadian National Research Laboratories. *Nature*, **125,** 31 (Jan. 4, 1930).—Outline of plans for new laboratories which will be completed early in 1931. C. E. M.

The Willard Gibbs Medal for 1930. See **The Willard Gibbs Medal** in the *Locals* on page 936.

The Perkin Medal. See this title in the *Locals* of the February JOURNAL, page 703.

Chandler Medal. See this title in the *Locals* of the March JOURNAL, page 469.

The Faraday Medal. See this title in the *Locals* of this issue of the JOURNAL, page 937.

American Institute of Chemists Award. See this title in the *Locals* on pages 937–8.

Popular Science Monthly $10,000 Annual Prize. See this title in the *Locals* on pages 938–9.

New York University School of Education. A National Educational Conference was held at New York University, February 28th and March 1st to celebrate the dedication of a new building for the School of Education. See title of **New York University** in the *Locals* on page 939.

National Education Association Exhibit. See title of **The National Education Association** in the *Locals* on page 000.

The Chilean Nitrate of Soda Nitrogen Research Award. See this title in the *Locals* on page 940.

FOREIGN CHEMICAL AND EDUCATIONAL CONDITIONS

Department of Agricultural Chemistry. F. O. SANTOS. *Philippine Agr.*, **18,** 281–90 (1929); *Chem. Abstr.*, **24,** 274 (Jan. 20, 1930).—A history of the development of chemistry and chemical teaching in the Philippines. The chemistry department of the Univ. of the Philippines was organized in 1910 under Mr. R. M. Holman. The following year Dr. H. G. Deming took charge and upon his resignation in 1916, Dr. M. L. Roxas was placed in authority. In 1910–11 only one course in chemistry was given while at present 26 are offered. C. E. M.

GENERAL

International Chemical Statistics. W. A. DYES. *Ind. Eng. Chem., News Ed.*, **7,** 10–1, 14 (Nov. 20, 1929). M. W. G.

Superfluous Publications. P. D. FOOTE. *Science*, **71**, 14 (Jan. 3, 1930).—F. considers most of the privately issued journals to belong to this class. They have limited circulations, are difficult to catalog, and because of miscellaneous content are inadequately reviewed. Workers in the institutions which publish such journals are usually forced to publish their work in them. G. H. W.

Big Changes Ahead. J. T. FLYNN. *American*, **109**, 11–3 (Jan., 1930).—An interview with C. F. Kettering, head of the Research Laboratories of the General Motors Corporation, proves the accuracy of the statement that "he specializes in stirring things up." He startles the reader by "Our business is to keep the customers dissatisfied."

Some changes which he forecasts include: express highways for our fast auto traffic, refrigerated homes as well as vapor-heated homes, a new and modern house that will entirely supplant any house built as long ago as 1900, new foods and new fabrics not buccaneered from either the animal or plant world but synthesized in factories. "Keep your eye on this wonderful science of organic chemistry," he admonishes, "it is going to do wonderful things to this country in the next decade or two." B. C. H.

Transformation of Energy by Rubber. I. WILLIAMS. *Rubber Chem. Tech.*, **3**, 74–86 (Jan., 1930).—Energy expended on raw or vulcanized rubber is consumed largely by producing plastic flow and reversible elastic strain. Most rapid energy transfer is the most completely reversible since plastic flow is reduced. Rebound increases with temperature, but is not greatly affected by vulcanization. Heat liberated by elastic strain can be transformed almost quantitatively into mech. work. Heat due to internal friction which will be caused by both elastic and plastic flow is not reversible. Sufficient increase in temperature causes large energy loss due to considerable but limited permanent flow of rubber. This cannot be plastic flow of elastic portion, since it is limited in extent, but can better be explained by some mechanical change such as breaking of anchorage between portions of plastic material and elastic network. C. W. E.

The Swelling of Vulcanized Rubber in Liquids. J. R. SCOTT. *Rubber Chem. Tech.*, **3**, 3–18 (Jan., 1930).—Influence of nature of swelling of liquids, of substances added to liquids, of nature of rubber, of external factors and relation between swelling and other properties of rubber are discussed at length. Practical applications of swelling tests are given. C. W. E.

Problem Children Have Too Little Calcium in Blood. Crossness, tiredness, misbehavior and all the other symptoms of problem cases, both child and adult, result when the blood has too little calcium, Dr. Walter Timme, of the Neurological Institute, has concluded. But whether dietary efforts to increase the calcium, by taking lots of milk, fresh fruits and vegetables, and cereals, would relieve the condition, Dr. Timme did not say in his recent address before the New York Academy of Medicine.

Scientists now think that the supply of calcium to the blood is controlled by the tiny parathyroid glands in the neck. When these glands reduce the supply of calcium there is apparently a disturbing effect on the nerves and subsequent conduct of the individual who then misbehaves, showing inordinate fatigability, irritability of temper, and at times even incorrigibility, non-amenability to discipline, and assaultiveness.

"They were easily aroused to a high pitch of anger at the slightest provocation," Dr. Timme said, "a word, an insinuation, or even a glance being sufficient to arouse intense antagonistic reaction. These patients became problem cases at home, at school, or in whatever environment they found themselves, because of their non-adaptability and uncompromising attitude. Occasionally their behavior became so exaggerated that apparently hypomaniac states developed therefrom and several of these patients had to be confined in institutions until the symptoms were ameliorated. At home, a harsh word from any member of the family, at the table for instance, would result in a plate or knife or some other utensil being thrown at the aggressor. In school, a blow, a shout, or a curse would be hurled at a fellow student or even at the teacher."

Upsets in the mutual relationships of the glands and nerves are responsible for many of the drug and alcohol habitues and the easily led characters among the criminal classes, Dr. Timme said.—*Science Service*

Local Activities

Purpose and Organization

The purpose of the Local Activities Section of the JOURNAL OF CHEMICAL EDUCATION is briefly but clearly stated in its title. Any items of local news from institutions, A. C. S. Sections, Teachers' Associations, or other organizations which are of such a nature as to make them of more than purely local interest rightfully belong to this Section.

The responsibility of reporting items for this section rests entirely with the local institutions and organizations. It is desirable to have a representative appointed to report news regularly. Suitable material sent to the editorial office before the 20th of each month will be published in the following month's journal. The Editorial Staff must necessarily reserve the right to abridge or totally reject any items submitted. If the following suggestions are followed, however, the necessity for such action will be largely obviated.

Material to Be Reported

1. Notices of local scholarships or fellowships and announcements of new or unusual courses in chemical education or special fields of chemistry.
2. Reports of dedication of new science buildings, stressing the unique features.
3. News notes concerning activities of prominent scientists and educators and of the honors and awards made to them.
4. Promotions within, or changes of, personnel of a department.
5. Notices of any special gifts to chemical organizations or departments—as fellowships, endowments, laboratory gifts, library gifts, etc.
6. Accounts of meetings, social functions, exhibitions, chemical entertainments, etc., which might be suggestive to other organizations. Where original or unusual features are included, it is desirable that they be described in some detail.
7. Any subscriber to the JOURNAL, desiring new teaching position or seeking eligible candidate for teaching vacancy, is entitled to two free announcements yearly in this column.

Situation Wanted: Young man of 29 desires teaching position in small college or large city high school in one of the middle western states. Holds Bachelor of Science degree in chemistry, having minored in physics and mathematics. Also has 40 hours of graduate work at the State University of Iowa toward a Doctor's degree, 30 hours of which have been in physical chemistry and research. Eight years of high-school teaching experience in three states, the last five years having been spent in present position. Would prefer position of teaching general chemistry with qualitative and quantitative analysis, but could also handle organic chemistry. Reason for desiring change is to secure a better position. Married. Methodist. Mason. Perfect health. For more details concerning qualifications, write RICHARD A. WORSTELL, Head of Science Department, Fort Madison High School, Fort Madison, Iowa.

The Willard Gibbs Medal. DR. IRVING LANGMUIR, associate director of the Research Laboratory of the General Electric Company, and recipient of many honors for achievement in chemical science, will receive the Willard Gibbs Gold Medal of the Chicago Section of the A. C. S. for 1930, it was recently announced by DR. W. V. EVANS, of Northwestern University, chairman of the Chicago Section. The presentation of this medal will be made to Dr. Langmuir at the annual Willard Gibbs banquet of the Chicago Section on May 24th.

The award is one of the highest distinctions which can be conferred upon a chemist. It is made annually to a scientist whose work in either pure or applied chemistry has received world-wide recognition. The medalists are chosen by a national jury composed of leaders in all branches of chemistry.

The nomination of Dr. Langmuir for the medal was "for fundamental work on atomic hydrogen and on surface relations and also on electrical discharge phenomena; also for his contributions of great importance to nearly all branches of physical chemistry, including high vacuum technic, electronics, thermochemistry and catalysis; and lastly for his presentation of a theory of atomic structure."

Dr. Langmuir's researches have been conducted in the fields of chemistry, physics, and engineering. They have been

carried out largely in the laboratories of the General Electric Company at Schenectady, N. Y., since 1909.

Since 1924 Dr. Langmuir has been pursuing investigations in the field of electrical discharges in gases, which present more complicated problems than discharges in a vacuum. He has succeeded in devising a new method of attack upon these problems by the use of electrodes called "collectors." In 1925 he developed the atomic hydrogen welding process which has opened up new possibilities in electric welding by using a hotter and more intensive reducing flame. For this achievement Dr. Langmuir was honored in 1928 with the Perkin Medal by the American Section of the Society of Chemical Industry.

At a recent national meeting of the American Chemical Society, Dr. Langmuir made known the results of researches which, it is predicted, may bring talking pictures into universal use in education.

Among the outstanding awards made to Dr. Langmuir have been the William H. Nichols Medal by the New York Section of the American Chemical Society for researches on chemical reactions at low pressures, 1915; the Hughes Medal by the Royal Society of London for researches in molecular physics, 1918; the William H. Nichols Medal for research on atomic structure, 1920; and the Rumford Medal by the American Academy of Arts and Sciences for researches on thermionic phenomena, 1921. Also the Cannizzaro Prize awarded by the Royal National Academy of the Lincei, Rome, Italy, 1925; the Perkin Medal, 1928; the School of Mines Medal by Columbia University for distinguished efforts in chemical science, 1929; the Chandler Medal by Columbia University for studies on the electrochemical interactions of tungsten, thorium, caesium, and oxygen, 1929 [*see* THIS JOURNAL, **7**, 2, 469 (Feb., 1930)]; and the Faraday Medal.

Previous recipients of the Willard Gibbs Medal have included SVANTE ARRHENIUS of Sweden, MADAME CURIE of France, SIR JAMES C. IRVINE of Scotland, and the following Americans: T. W. RICHARDS, L. H. BAEKELAND, IRA REMSEN, ARTHUR A. NOYES, WILLIS R. WHITNEY, E. W. MORLEY, W. M. BURTON, W. A. NOYES, F. G. COTTRELL, J. STIEGLITZ, G. N. LEWIS, M. GOMBERG, J. J. ABEL, W. D. HARKINS, and CLAUDE S. HUDSON.

The medal, founded by WILLIAM A. CONVERSE, was named for JOSIAH WILLARD GIBBS, who was professor of mathematical physics in Yale from 1871 until his death in 1903. Though not primarily a chemist, Gibbs did much to advance the science of chemistry, and his papers are among the most important contributions that have been made to this branch of science.

The Faraday Medal. According to *Science Service*, SIR ERNEST RUTHERFORD [*see* THIS JOURNAL, **7**, 3, 492–5 (March, 1930)], the physicist who made alpha rays from radium knock hydrogen out of various light chemical elements, thus accomplishing transmutation, and who has been president of the Royal Society, Great Britain's leading scientific society, since 1925, has been awarded the Faraday medal by the British Institution of Electrical Engineers.

Sir Ernest Rutherford is a foremost British scientist and has notable accomplishments to his credit in different fields. In 1908 he was awarded the Nobel Prize for chemistry. The Faraday medal is given for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, irrespective of the recipient's nationality.

American Institute of Chemists Award. Official announcement was recently made that the American Institute of Chemists had awarded its medal "for noteworthy and outstanding service to the science of chemistry and the profession of chemist in America" to MR. GEORGE EASTMAN. In making this announcement, DR. FREDERICK E. BREITHUT, president of the

Institute, referred to Mr. Eastman as "one of the greatest lay-scientists of the present day."

Mr. Eastman's research work toward simplifying and popularizing photography was begun in 1883 with his first attempts to make the now well-known roll film, and it was a chemical discovery—the use of nitro-cotton dissolved in the proper solvents—which marked the turning point of his career.

The most noteworthy service to American chemistry in Mr. Eastman's career was made in 1918 when he approved the establishment by the Research Laboratory of a department of synthetic organic chemistry to manufacture and supply the various synthetic organic chemicals required for research purposes in the United States. The primary object of this much-needed move was to insure the complete independence of the United States in regard to these essential materials, and it received the coöperation and active support of both industrial and academic chemists throughout the country. Continued coöperation with all available sources of supply, and an active production program have increased the number of available chemicals to over 2600—a number of high quality organic chemicals greater than that of any other country. The value of this work was recognized publicly when the Synthetic Organic Chemical Manufacturers Association, in 1925, made Mr. Eastman an honorary member.

International Congress of Mining, Metallurgy, and Applied Geology, Liège, June 22–28, 1930. Following the decisions at Düsseldorf in 1910, the sixth session of the International Congress of Mining, Metallurgy, and Applied Geology will be held at Liège during the International Exhibition of 1930 from June 22nd to 28th. These meetings will be under the patronage of His Majesty King Albert and of the Belgian Government. The congress has been organized by the Liège Association of Engineers and the Geological Society of Belgium at Liège, in consultation with the societies which took part in the conference at Düsseldorf. The subjects to be dealt with are as follows:

A. Mining Section.—Reconnaissance and preliminary work. Modern methods of working coal mines, metalliferous deposits, and quarries. Generation and utilization of energy. Extraction. Ventilation (gas and dust). Mechanical treatment of ores and coal. Various.

B. Metallurgy Section—Blast-furnace (use of high-duty blast-furnace, treatment of by-products). Steel and ferrous alloys (corrosion, ingot-casting, rails, thin sheets). Foundry (analyses of pig-irons, high-resistance pig-irons, chilled iron, foundry sands, malleable cast-iron). Non-ferrous (influence of concentration by flotation of minerals on their metallurgical treatment, production of metals by electrolysis, effect of mining and metallurgical developments in the Belgian Congo on metallurgy in Belgium). *Sub-section: Non-ferrous alloys.*—Light alloys. Alloys containing cobalt. Non-ferrous alloys used for cutting metals. Metallic plating. *Sub-section: Fuels.*—Reactivity of fuels. Use of gaseous fuel. Thermal control.

C. Applied Geology Section.—Metals. Fuels. Hydrology. Geophysical prospecting. Various.

All individuals, societies, institutions, and public bodies interested in the art of mining, metallurgy, or applied geology can join the Congress either as patron-members (with a minimum subscription of 200 belgas) or as active members (with a subscription of 30 belgas per section, in addition to 10 belgas for each supplementary section). Programs, list of papers, and other information may be obtained on application to the General Secretary of the Organizing Committee, 16, Quai des États-Unis, Liège.—*Chem. & Ind.*

Popular Science Monthly $10,000 Annual Prize. The largest single monetary award in America for scientific accomplish-

ment has been created by *Popular Science Monthly*, which, beginning this autumn, will confer an annual prize of $10,000, accompanied by a gold medal, upon the American citizen who has been responsible, during the preceding year, for the achievement in science of greatest potential value to the world.

In making this announcement, O. B. CAPEN, president of the Popular Science Publishing Co., explained that the award was instituted with a dual purpose—to heighten the interest of the American people in those conquests of the laboratory and the workshop which benefit the entire community, and to focus attention upon the many scientific workers who, without thought of personal profit, toil to better man's control over his physical surroundings.

The award will be bestowed under the auspices of the Popular Science Institute, a research organization maintained by the magazine, of which COLLINS P. BLISS, associate dean, New York University, is director. The institute has enlisted the services of twenty-four leaders in American science to serve as a Committee of Award, whose task it will be to select the prize-winning effort.

The prize will be conferred for the first time in September, 1930, and the initial period of scientific accomplishment to be considered by the Committee of Award will be the twelve months ending June 30, 1930. All scientific workers, professional and amateur, academic and commercial, are eligible.

The distinguished men comprising the Committee of Award are: Charles G. Abbot, Collins P. Bliss, Samuel A. Brown, George K. Burgess, William W. Campbell, Harvey N. Davis, Arthur L. Day, E. E. Free, Travis Hoke, Frank B. Jewett, Vernon Kellogg, Charles F. Kettering, Arthur D. Little, John C. Merriam, Robert A. Millikan, Henry Fairfield Osborn, Elmer A. Sperry, Samuel W. Stratton, Elihu Thomson, Edward R. Weidlein, Henry Herman Westinghouse, Albert E. White, Willis R. Whitney, and Orville Wright.—*Ind. Eng. Chem., News Ed.*

The National Education Association. More than 250 exhibitors of school supplies and equipment displayed textbooks, apparatus, and other devices used as classroom tools of learning, in a great educational fair held in connection with the annual convention of the Department of Superintendence of the National Education Association at Atlantic City, February 22nd–27th.

Once a new content or method in education meant only a new textbook. Now the inventive minds of every scientific, industrial, and commercial field are directed to the construction of apparatus and supplies designed for supplementing books.

The Atlantic City Auditorium, the largest building of its kind in the world, offered a special opportunity for this exhibition. Located under the same roof as the general sessions and many of the sectional meetings of the convention, it is large enough to permit inspection by thousands of visitors without congestion.

Visual education received more attention this year than ever before. The talking motion picture was exhibited as an educational device for the first time. Micro projectors, projection machines, educational films, pictures, and prints were entered in large number. The tendency of the fair to express the convention theme "Education Is Life" was shown in the varied uses of present-day interests for vitalizing education. Maps were exhibited which take advantage of the recent events in aviation for bringing geography up to date. Another series of maps named the countries and cities of the world in the languages used by their inhabitants instead of the Anglicized version of these names, so that schools may further supplement modern transportation and communication in making distant peoples more intimate to American life.

The textbook exhibit was unusually

large and interesting. Books on character education attracted many convention visitors. One novelty among these exhibits was a textbook on aviation. The first handsaw to be shipped across the ocean by air, an intimation of the future development of this type of transportation, was displayed by one exhibitor. Plumbing, sanitary supplies, scrubbing machines, floor oils and wax, cleaning chemicals, heating and ventilating equipment, brooms, fire alarms, and electric bell systems were exhibited.

School furniture, school buses, office equipment and supplies were entered by a large number of exhibitors. The laboratory apparatus field was well represented.

The Chilean Nitrate of Soda Nitrogen Research Award. About two years ago the Chilean Nitrate of Soda Educational Bureau of New York made available an annual appropriation of $5000 to be distributed in the form of one or more prizes for outstanding research in this country and Canada on nitrogen in its relation to soil processes and plant growth. This sum has been placed in the hands of the American Society of Agronomy, the award being administered by a special committee of the society.

The first awards were made in 1928. The committee held then that it was advisable to select older investigators whose previous work in advancing knowledge of nitrogen in relation to plant growth has been beyond question. PROFESSOR J. G. LIPMAN, director of the New Jersey Agricultural Experiment Station, PROFESSOR T. L. LYON, chief of the soil department, Cornell University, PROFESSOR E. B. FRED, division of agriculture, bacteriology, University of Wisconsin, and PROFESSOR F. T. SHUTT, dominion chemist, Ottawa, Canada, were those selected. In connection with the announcement of the selections for 1928 the committee suggested that subsequently it would be appropriate to consider and perhaps even give preference to those younger investigators who have made recent contributions to the subject.

The second award, announced at the 1929 meeting of the society, was divided among three investigators, namely, PROFESSOR C. A. MOOERS, director of the Tennessee Agricultural Experiment Station; PROFESSOR P. L. GAINEY, soil bacteriologist of the Kansas Agricultural Experiment Station; and PROFESSOR S. A. WAKSMAN, microbiologist of the New Jersey Agricultural Experiment Station.

In making the 1930 award, investigations will be considered which deal with the physical, chemical, or microbiological transformation of both organic and inorganic nitrogen in the soil, the absorption and utilization of nitrogen by plants and nitrogen fertilizer in any of its aspects. The committee will give particular attention to those contributions which have been published within the past year or two. Investigations of longer standing will also be considered, provided the authors are still actively engaged in the work.

Investigations dealing with any phase of nitrogen in relation to soils and crops may be called to the attention of the committee either by an author himself or by any one else. The award, which may be made either to one or more investigators, will be recommended to the society, according to the judgment of the committee.

The committee is now soliciting nominations of candidates for the 1930 award. The nominations should be made in writing and may be addressed to any member of the committee. Although it may be difficult to select the "most" outstanding contribution to such a complex subject as nitrogen in its relation to soils and plants, the committee hopes that it will at least be able to select one or more investigators who have made a notable contribution to the scientific understanding of the rôle of nitrogen in soils and plants. It is expected that the award will be used in such a way as to lead to still higher scientific activity.

The award which will be made at the 23rd annual meeting of the American Society of Agronomy in November, 1930, is open to investigators irrespective of their connection with the American Society of Agronomy. The investigation may have been made at a university, state experiment station, government institution, or privately. Any further information desired may be secured from the committee which consists of R. W. THATCHER, C. B. WILLIAMS, W. P. KELLEY, R. I. THROCKMORTON, R. BRADFIELD, and S. A. WAKSMAN, *Chairman*.

Tenth Annual Ohio State Educational Conference. During the meeting of the conference at the Ohio State University, there will be a brief business meeting of the Ohio Chemistry Teachers Association on Friday, April 4th, at noon after the luncheon of the Non-Biological Science Section.

Brown University. DR. E. M. SHELTON, chief chemist, Cheney Bros., South Manchester, Conn., addressed the Rhode Island Section of the A. C. S. at the February meeting. The title of his talk was "Silk, a Field for Research." On March 14th, DR. ARTHUR E. HILL, of New York University, addressed the section on the topic, "Phase Rule Studies of Certain Salt and Water Systems."

The first John Howard Appleton Lecture for the year 1929-30 was held on February 5th. PROFESSOR KASIMIR FAJANS, professor of physical chemistry at the University of Munich and visiting professor at Cornell University this semester, lectured on the subject "The Deformation of Electron Shells in the Light of Refractometric Data." Preceding the lecture a dinner was given for Dr. Fajans at the Brown Faculty Club. At 5 o'clock, tea was served in the Chemistry Club room. Members of the staff and their wives were invited to meet Dr. and Mrs. Fajans.

The Students' Chemistry Club met on Friday, February 21st. ELLERY L. WILSON, vice president and general superintendent of the Rumford Chemical Works, spoke to the Club on "What Industry Expects of Its Chemists."

According to *School and Society*, DR. SAMUEL T. ARNOLD, associate professor of chemistry, has been appointed dean of undergraduates. The title given to Dr. Arnold is a new one, replacing that of dean of the university, which has been in use since the post was first held by Dr. Winslow Upton in 1900.

College of the City of New York. PROFESSOR HERBERT R. MOODY, director of the department of chemistry, has received a leave of absence for the spring term. He will devote considerable time to a study of chemical industries in Italy and Southern France, and will also attend the annual meeting of the Society of Chemical Industry in Birmingham, England, in July. While he is away, PROFESSOR RESTON STEVENSON will act as director of the department.

A new student chapter of the American Institute of Chemical Engineers has just been authorized here.

The Alumni Section of the Baskerville Chemical Society held its 4th Annual Dinner on December 21, 1929. These gatherings provide the graduates of the college in the chemical and allied professions with a means of renewing old acquaintances and have been well attended.

PROF. L. J. CURTMAN and M. WIGLER published an article in the December 6th and 13th issues of *The Chemical News* entitled, "The Removal of Interfering Acids Prior to Systematic Metallic Analysis."

Columbia University. PROFESSOR V. K. LA MER has returned from a lecture tour in the Middle West. He addressed the A. C. S. Sections of the Universities of Wisconsin, Iowa, Nebraska, Kansas, and Illinois on the subject of the "Modern Theory of Electrolytes" and the Ames Section on "Reaction Velocity in Ionic Systems."

PROFESSOR H. C. SHERMAN sailed on February 13th to deliver a series of four lectures on recent advances in the chemistry of nutrition at the Institute of Tropical Medicine, San Juan, Porto Rico.

PROFESSOR MARSTON TAYLOR BOGERT was elected a foreign member of the Royal Society of Sciences of Bohemia, at their recent January meeting. This organization is the oldest of the Czechoslovakian learned societies, and one of the oldest in central Europe, having been founded in the year 1770 by Czech noblemen.

Howard College. At the Founders' Day Exercises held on February 7th there was presented to the department of chemistry a chemical cabinet used by DR. NOAH K. DAVIS in 1855 when he was professor of natural philosophy at Howard College.

DR. FRANK L. JONES has resigned as associate professor of chemistry to accept a senior fellowship at the Mellon Institute. MR. F. C. VON WICKLEN, who has been assistant chief chemist of the Graham-Paige Motors Corporation, has taken over the duties in industrial and analytical chemistry.

Loyola College. The Seminar conducted by the Chemists' Club of Loyola College is being held during the second semester, on Friday afternoons, at 2.30 P.M. The subjects and dates of future meetings are as follows:

March 21st: "Chemistry of Radio—Incandescent Lamps," B. L. EVERING, '30. "Carbon Dioxide," F. A. SANDERS, '31.

April 4th: "Chemistry and Health," M. MACKEY, '31. "The Chemist's Contribution to Aviation," J. J. EGAN, '31.

April 25th: "Chemistry and the Home," E. L. RODOWSKAS. "Chemistry and Disease," W. C. DUNNIGAN, '31.

May 2nd: "Portland Cement," J. J. BROENING, '31. "Colloids," R. H. DICKERSON, '31.

May 9th: "By-Products in Industrial Chemistry," E. EDELMANN, '33.

A series of lectures by professional chemists is being given on Tuesday afternoon, at 2.30 P.M., in Room 210, of the Science Building.

March 25th: REV. R. B. SCHMITT, S. J., professor of chemistry, Loyola College—"Amino Acids and Digestion."

April 1st: DR. LOUIS C. ROCHE, Maryland Glass Corporation—"The Chemistry of Glass Manufacture."

April 8th: DR. J. BOISEAU WIESEL, chemical engineer—"Nitro-Cellulose Lacquers."

May 6th: DR. WM. M. THORNTON, JR., associate professor, The Johns Hopkins University—"General and Industrial Chemistry of Titanium." (Specimens and lantern slides.)

The Johns Hopkins University. The fourth lecturer at The Johns Hopkins University on the DOHME FOUNDATION was DR. C. M. A. STINE, Chemical Director of E. I. du Pont de Nemours & Co., who spoke before the chemistry staff and graduate students on Friday, February 14, 1930. His talk was a discussion of chemical research now in progress at various universities recently visited in England and Holland, with particular reference to the work of Professor Bone, chief professor of chemical technology at the Imperial College of Science and Technology in London.

Following the lecture, the customary departmental dinner was attended by about forty students and faculty members. DR. A. R. L. DOHME entertained the group by a description of his recent trip to Mexico.

DR. R. A. MILLIKAN, of Stanford University, will deliver the fifth lecture of the DOHME FOUNDATION on April 23rd.

In response to the invitation of DR. J. C. W. FRAZER, chairman of the department of chemistry, a conference was held at the chemical laboratories of the Johns Hopkins University on February 12, 1930, at which representatives of the science faculties of the university met those of the American Cancer Com-

mittee in the interests of a closer cooperation in the future between chemistry and medicine. The Surgical, Pathological, and Garvan Experimental Laboratories of the university were represented.

Kansas State Agricultural College. The local section of the A. C. S. met on Friday, February 7th, at 7.30 P.M., in the large lecture room of the chemistry building. DR. H. N. BARHAM, assistant professor of chemistry, addressed the society on the topic, "The Future of Mold Chemistry." Dr. Barham was a research chemist in the Henry L. Doherty laboratory at Talland, Oklahoma, for the two years previous to his coming to the Kansas State Agricultural College in September, 1929.

See also **Pennsylvania State College.**

Lehigh University. For the past three years the students in freshman chemistry at Lehigh University have donated the residue of their laboratory deposit fees to the department of chemistry to be used for the support of chemical research in that university. From this fund two graduate fellowships in chemistry, paying $750 and free tuition, have been granted each year and, in addition, a surplus fund is being accumulated. This idea was initiated by the freshmen themselves, and has been carried on by succeeding classes of freshmen.

Medical College of Virginia. MAJOR W. CATESBY JONES has been appointed acting chief chemist of the Department of Agriculture Laboratory in Virginia to succeed DR. J. B. WEEMS, who died early in February. Major Jones is a graduate of Virginia Polytechnic Institute and during the War was stationed at the American University.

Mellon Institute of Industrial Research, University of Pittsburgh. DR. E. R. WEIDLEIN, director, Mellon Institute of Industrial Research, has announced the appointment of H. E. FOOTE (Ph.D., Brown University, 1917) to the incumbency of the Institute's Industrial Fellowship on Oxygen. This Fellowship has been established by the Gas Industries Company, Inc., Pittsburgh, Pa., designer and builder of liquid-air oxygen apparatus. The investigation is to be concerned with the extension of the present uses of oxygen, and in particular with the application of cheap oxygen in various industrial processes, including metallurgical operations and technically important organic oxidation reactions.

Dr. Foote has been a member of the Institute's investigational staff since 1927. He was previously engaged in research at the Philippine Bureau of Science, Manila, P. I.

New York University. During the National Educational Conference held at New York University to celebrate the dedication of the new building of the School of Education, one of the features of the Round-Table Conference on Science Education was a symposium on the subject, "What constitutes a desirable program of studies in science education for teachers of science in secondary schools?" DR. S. R. POWERS, of Teachers College, Columbia University, was leader of the discussion, and the speakers were PROFESSOR E. R. DOWNING, of the University of Chicago, PROFESSOR C. W. FINLEY, of New Jersey State Teachers College, and PROFESSOR F. D. CURTIS, of the University of Michigan.

The Ohio State University. *See* **Tenth Annual Ohio State Educational Conference.**

Pennsylvania State College. MRS. PAULINE BEERY MACK, of the chemistry department of The Pennsylvania State College, lectured before various groups of consumers and students on recent advances in textile chemistry, at Kansas State College, Manhattan, February 6th; University of Missouri, Columbia, February 7th; and University of Illinois, Urbana, February 8th.

A clothing and textile chemistry research conference was held at Kansas State College, Manhattan, February 5th to 7th. Representatives of seventeen colleges were in attendance. The purpose of the conference was to discuss means of elevating the level of research in the clothing and textile field, and to find out whether research projects could be set up which might lend themselves to coöperative work. Leaders of the various sessions of the conference were: DEAN MARGARET A. JUSTIN, of Kansas State College, Manhattan, who is president of the American Home Economics Association; MRS. PAULINE BEERY MACK, of The Pennsylvania State College; MISS RUTH O'BRIEN, of the Bureau of Home Economics, Washington; and MISS ETHEL PHELPS, of the University of Minnesota.

Princeton University. On January 24th, ROGER ADAMS spoke before the Chemical Club on "Synthetic Acids in the Treatment of Leprosy."

At the chemical colloquia held during the past winter the following papers were given: "Conduction in Metals," PROFESSOR T. J. WEBB, January 15th. "Reactions of Oxygen Atoms," DR. G. B. KISTIAKOWSKY, February 5th. "Surface Reactions of Atoms and Molecules," PROFESSOR H. S. TAYLOR, February 11th.

PROFESSOR G. B. KISTIAKOWSKY, research associate, has accepted a call to Harvard University and will assume his duties there at the beginning of the next academic year.

Through the generosity of Merck and Co., Inc., of Rahway, New Jersey, a Fellowship in Analytical Chemistry with a stipend of $1000 has been established at Princeton University for the academic year 1930–1931. The purpose of the fellowship grant is to foster fundamental research in the development of new or improved qualitative and quantitative analytical methods.

Stanford University. The chemistry department has recently had the following lectures:

PROFESSOR E. C. FRANKLIN, former president of the American Chemical Society, spoke informally about his recent trip to South Africa as the guest of the British Association for the Advancement of Science, illustrating his talk with motion pictures.

DR. H. W. MORSE, consulting chemist and metallurgist, spoke on "Periodic Crystallization."

PROFESSOR G. N. LEWIS, dean of the college of chemistry at the University of California, spoke on "Symmetry of Time in Chemistry and Physics."

PROFESSOR H. G. GRIMM, of the University of Würzburg, Germany, gave two lectures on "Atomistics and the Systemization of Chemical Compounds."

PROFESSOR R. T. BIRGE, of the University of California, gave four lectures on "Band Spectra."

A talking motion picture, "Oil Films on Water," featuring Dr. Irving Langmuir of the General Electric Company, was recently exhibited at a local theater.

DR. FARRINGTON DANIELS, of the University of Wisconsin, will be a visiting professor at Stanford University during the coming summer quarter, giving courses on modern physical chemistry and mathematical chemistry.

The State College of Washington. DR. HARRISON E. HOWE, editor of *Industrial and Engineering Chemistry*, gave a series of addresses at the State College of Washington on February 11th.

In the morning he spoke to the student body on "Chemistry in the New Competition." In the afternoon, he addressed an open meeting of the local section of the A. C. S. on "Discoveries of Tomorrow." The same evening Dr. Howe was the guest of honor at a banquet sponsored by Chi chapter of Phi Lambda Upsilon. His remarks on this occasion related to the editorial work of *Industrial and Engineering Chemistry*.

The itinerary of Dr. Howe's speaking tour, which includes twenty-two colleges and universities, was arranged by DR.

J. L. ST. JOHN, former president of the local section of the A. C. S.

Tufts College. The student Chemical Society recently joined with the undergraduate professional societies of the Engineering School as sponsors for the "Annual Engineers Ball." There were about two hundred present, PROFESSOR and MRS. BAKER representing the chemistry faculty.

DR. WORRALL represented Tufts College at the A. C. S. meeting at Princeton in December.

The seniors are all actively engaged in their individual problems required in thesis work. The analytical problems include investigations on "The Iodide Method for Copper," "The Jones Reductor Method for P in Iron," "The Volatilization of Arsenic in White Metal Analysis," "The Polishing and Etching of Soft Metals."

State University of Iowa. DR. ERLE M. BILLINGS, of the Eastman Kodak Co., Rochester, N. Y., visited the chemistry department on January 30th.

DR. H. S. COITH and MR. H. VAN BUREN of the chemical division of the Procter & Gamble Company, Cincinnati, Ohio, visited the chemistry department on February 3rd.

MISS MILDRED M. HICKS was granted the Ph.D. degree with major in physical chemistry at the February 4th convocation. Miss Hicks is at present assistant chemist at the Bureau of Standards.

MR. CECIL E. SCOTT, M.S., Iowa, 1928, has accepted a position as chemist with the Procter & Gamble Co. During the past year, Mr. Scott has been assistant in the chemistry department at the University of Iowa.

HERMAN YORK, B.S., Iowa, 1929, has sailed for Chile, where he has accepted a position as chemical engineer with the W. R. Grace Phosphate Mining Company.

MR. WALTER G. MEYER, B.S., Iowa, 1929, who is at present doing graduate work in chemical engineering, has accepted a position with the Procter & Gamble Company.

PROFESSOR H. L. OLIN attended the Committee on Coal Classification of the American Institute of Mining and Metallurgical Engineers in New York, February 17th–20th. He represented Iowa in the discussions on coal classification with particular reference to the coals of that state, on which he has made special studies.

The University of Chicago. DR. T. R. HOGNESS, of the University of California, has joined the chemistry staff. He assumed his duties January 1st.

MR. JOHN MEILER, MR. WILLIAM VAUGHAN, MR. CALVIN FULLER, and MR. HUBERT F. JORDAN received the Ph.D. degree at the December convocation. Mr. Meiler is an instructor in chemistry at the University of Nebraska; Mr. Vaughan is an instructor in chemistry at the University of Chicago; Mr. Fuller is connected with the *Chicago Tribune;* and Mr. Jordan has a research position with the United States Rubber Company.

At the December convocation, in connection with the dedication of the George Herbert Jones Laboratory, the honorary degree of Doctor of Science was conferred on DR. G. N. LEWIS of the University of California, DR. M. GOMBERG of the University of Michigan, and DR. HERMAN A. SPOEHR, Ph.D., alumnus of the University of Chicago and associate director of the Coastal Laboratory, Carnegie Institution, Palo Alto, California.

MISS RUTH WATTS, who has completed her work for the Ph.D. degree, has received a research appointment under DR. GUSTAFSON in the department of physiological chemistry at the university.

DR. L. M. HENDERSON, Ph.D., 1916, has contributed the sum of $100 for use in the George Herbert Jones Laboratory. It will be used for framing pictures of prominent alumni to be hung in the men's common room under the direction of the Kent Chemical Society.

The department has inaugurated a seminar for the staff and graduate students to be held semi-monthly. The first meeting took place February 3rd, with Dr. Harkins leading the discussion on the subject, "The Application of Physical Chemistry to Some Organic Problems."

University of Florida. The university has just announced its first short course in Water and Sewage Treatment, to be given April 8th to 11th, inclusive. The course will be offered through the General Extension Division. PROFESSOR A. P. BLACK, of the department of chemistry, will be general chairman of the committee in charge of the course. A university bulletin giving full particulars as to the course will be available at an early date.

University of Idaho. DR. HARRISON E. HOWE addressed the weekly student assembly in the morning and the annual open meeting of the Society of Sigma Xi in the afternoon of February 19th. Both addresses were well received and the attendance at both was excellent.

University of Maine. At the meeting of the Maine Section of the A. C. S. on February 21st, J. G. CAULFIELD told of his experiments during the past four years in dyeing the standing hardwood trees, a procedure, which, though interesting, is apparently not economic. F. HYLAND described general and specialized technic employed in the preparation and staining of wood for microscopic studies.

P. D. BRAY attended the annual meeting of the Technical Association of the Pulp and Paper Industries in New York during the week beginning February 17th.

Senior students in chemistry and chemical engineering have begun plant inspection trips on Saturday mornings. These are scheduled for the first half of the second semester of the senior year. They include a week spent in and about Boston inspecting industrial manufacturing operations in which chemistry plays a large part. The Boston trip is scheduled for the week preceding the spring vacation. In May, it is planned to spend a day inspecting the modern lime plant of the Rockland and Rockport Lime Co. at Rockport and the modern cement plant of the Lawrence Cement Co. at Thomaston.

On February 17th, DR. C. A. BRAUTLECHT addressed the orientation course class, composed of freshmen in the College of Arts and Sciences, for the second time during the year. The first address outlined the history and development of chemistry; the second dealt with branches of chemistry, the chemist and his work, opportunities for chemists, and the economics of chemical activities.

University of Minnesota. According to *School and Society*, the regents of the University of Minnesota voted on December 21st to take out an insurance policy for more than $6,000,000 providing death and total disability benefits to 800 in the employ of the university. The policy was awarded on a joint bid to the Northwestern National Life Insurance Company of Minneapolis and the Minnesota Mutual Life Insurance Company of St. Paul. Faculty members will be covered by $10,000 policies each and employees by policies of $1000 or $2000, depending on the length of their service. The annual gross premium will be about $100,000, of which the university will pay slightly under 40 per cent and those insured the remainder.

University of Missouri. MR. ALBERT C. KRUEGER, formerly instructor at the University of Missouri, now of the University of Wisconsin, visited the University of Missouri on February 4th.

DR. OSCAR B. MUENCH (B.A., University of Missouri, 1913, M.A., University of Missouri, 1915, and Ph.D., University of Colorado, 1928), now of the New Mexico Normal University, Las Vagas, New Mexico, is doing research work under Dr. Schlundt, determining

the lead uranium ratio in a new radioactive mineral called "cyrtolite." This mineral occurs near Bedford, Westchester County, New York.

University of Nebraska. The January and February issues of *The Journal of the American Chemical Society* contained articles by members of the chemistry staff of the University of Nebraska. "The Oxidation Potential of the Lead Dioxide Electrode in Perchloric Acid Solution," in the January number of the journal, was written by PROFESSORS D. J. BROWN and JOHN C. ZIMMER. PROFESSORS CLIFF S. HAMILTON and F. E. CISLAK have an article in the February issue on "A Method of Determining the Arsenic Content of Organic Arsenicals." DR. JOHN G. MEILER and DR. W. ALBERT NOYES, JR., of Brown University, also have an article in the February number on "The Electronic and Photochemical Decomposition of Potassium Chlorate."

MR. VAN BUREN, of the Procter & Gamble Co., and DR. ERLE BILLINGS, of the Eastman Kodak Co., visited the chemistry department recently to interview students who expect to go into industrial work.

DR. SAMUEL AVERY, formerly chancellor of the university, is now research professor in chemistry. Dr. Avery, acting as host in the absence of CHANCELLOR BURNETT, gave a radio address as part of the University Charter Day program, February 15th.

PROFESSOR S. C. LIND, director of the school of chemistry at the University of Minnesota, addressed the February meeting of the Nebraska Section of the A. C. S. His subject was "Radioactivity and Its Contributions to Other Sciences." After a general survey of the radioactive elements and their properties, Dr. Lind pointed out how through radioactive equilibriums the age of the earth has been calculated. From the known distribution of radioactive deposits on the earth it is possible to calculate the amount of energy produced by their disintegration, and to determine whether the earth is cooling down or warming up. If the distribution of radioactive elements is the same for a distance of twenty miles into the earth as it is on the earth's surface, then the earth is warming up. From this assumption, the geologist, Joly, proceeds to establish a theory of volcanic eruptions which have in past ages spelled the death and rebirth of civilizations on the earth. Dr. Lind pointed out the increasing uses to which radioactive elements are being put in the field of medicine, commerce, and chemistry. Although some benefits have been derived from treating soils with radioactive elements, it is not as yet practicable. Some use has been made of radioactivity in the development of new species. Based on this, a suggestion has been made that all evolution has been caused by radiations, either radioactive or cosmic.

University of Tennessee. The first of the open meetings sponsored by Alpha Phi chapter of Alpha Chi Sigma was held Thursday night, February 6th, in the chemistry building. MR. W. H. LOCKWOOD, first lieutenant in the Chemical Warfare Service and instructor in the department, addressed the group on "Chemical Warfare." The talk was illustrated by gas masks, hand grenades, samples of warfare gases, and other similar materials.

MR. C. H. HALE, JR., a fellow in the department, has accepted a position with the du Pont Ammonia Corporation.

University of Virginia. CLAUDE S. HUDSON, professor of chemistry in the Hygiene Laboratory of the U. S. Public Health Service, addressed the School of Chemistry at the University of Virginia on Thursday, February 6th, at 8.30 P.M. His subject was the "Ring Structures of the Sugars," one which he recently gave at the Organic Symposium at Princeton and which he has been invited to give before the International Union of Pure and Applied Chemistry at the meeting

in Liège, Belgium, next September. The speaker's recent achievements are the result of his long association with allied problems in his many university and government laboratory contacts. He was the Nichols medalist in 1916.

Dr. Hudson has developed a method of determining ring structures of the sugars through the relation of configuration and structure to rotatory power of the sugars and their glucosides. He was able to demonstrate, with the aid of a considerable amount of data, that a given group or arrangement in the sugar series had a definite rotatory power regardless of the variation in structure (and rotation) of the rest of the molecule, and from the data was able to calculate with a high degree of accuracy the rotatory powers of a number of groups and arrangements. From this knowledge the unknown ring structures of known or new sugars were determined by relating the rotatory power of the part of the molecule (of unknown structure) to those of known arrangements. Thus, on the basis of his theory, he showed that the ring structure for starch and most ketoses was 1.4 and that for glucose and cellulose was 1.5. According to his theory, then, the conclusions of Irvine and of Haworth regarding many ring structures are erroneous.

Dr. Hudson has added to his already great achievements in his study of structural sugar chemistry by utilizing and analyzing the rotatory powers of the various sugars in such a masterly manner as to enable him to take a long step forward in solving one of the most complex and interesting problems of sugar chemistry, namely, the ring structure.

Wesleyan University. Professor G. Albert Hill has been reappointed by the College Entrance Examination Board to its Committee of Examiners and to its Committee of Readers in Chemistry.

Western Reserve University. The division of chemistry of the summer session announces the appointment of PROFESSOR L. CHARLES RAIFORD, professor of organic chemistry, Iowa State University, as visiting professor for the forthcoming summer session. Professor Raiford will offer two courses of lectures, one on "Organic Nitrogen Derivatives," covering the structure, methods of synthesis, and types of reactions of a selected list of some of the more important organic compounds containing nitrogen; the other one on "Type Reactions in Organic Chemistry," dealing with types of unsaturation, the negative nature of certain groups of radicals, selected cases of ring formation, orienting influence in the benzene system, and steric hindrance.

In addition, the department will offer a number of other courses of interest to teachers, such as chemical microscopy, both elementary and advanced, physical chemistry, food analysis, chemical industries in Cleveland, involving trips to typical plants, and the usual courses in elementary chemistry, qualitative and quantitative analysis.

On February 18th, PROFESSOR H. S. BOOTH, of the chemistry department, addressed the Erie Section of the A. C. S. on "Chemical Microscopy."

New England Association of Chemistry Teachers. A meeting of the N. E. A. C. T. was held at Brown University on March 29, 1930, and another will be held at the Connecticut College of Pharmacy on April 12, 1930.

Central Pennsylvania Section, A. C. S. The thirty-third meeting of the Central Pennsylvania Section of the A. C. S. was held at The Pennsylvania State College, on Tuesday, January 28th. DR. FRANK C. WHITMORE, dean of the school of chemistry and physics, addressed the section on "The Preparation and Use of the Organic Compounds of Mercury."

The Cincinnati Section, A. C. S. The 312th meeting of the Cincinnati Section, A. C. S., was held in McMicken Auditorium of the University of Cincinnati on February 12, 1930, at 8.00 P.M.

The speaker for the evening meeting was MR. THOMAS MIDGELEY, JR., of The General Motors Corporation, who lectured on "The Products of the Destructive Distillation of Rubber."

A special meeting of the Cincinnati Section was held in the auditorium of the chemistry building of the University of Cincinnati on Wednesday, February 26, 1930, at 8.00 P.M. The program consisted of a lecture by PROFESSOR CHARLES A. KRAUS, of Brown University, who spoke on the topic, "The Boundary between Organic and Inorganic Chemistry."

Erie Section, A. C. S. *See* **Western Reserve University.**

Florida Section, A. C. S. The twenty-fifth meeting of the Florida Section of the A. C. S. was held in the auditorium of the St. Petersburg Junior College, St. Petersburg, Florida, on the evening of January 25th.

DR. ROE E. REMINGTON, director of the Food Research Laboratory of the State of South Carolina, was the chief speaker. He took for his subject "The Geochemistry of Iodine and Its Relation to Goiter." Dr. Remington and his staff are doing important pioneer work in their investigations of the iodine content of fruits, vegetables, and soils, and his address was quite appropriate because of the attention which is now being devoted to that subject in Florida.

Dr. Remington was introduced and welcomed to Florida by DR. CHARLES N. NORTHEN, personal representative of GOVERNOR DOYLE CARLTON, who was unable to be present.

Following Dr. Remington's address, MR. CLAUDE E. STREET, of Bradentown, president of the Florida Iodine Research Commission, spoke briefly of work now in progress and plans for future investigations to be fostered and supported by his organization.

The meeting was open to the public. DR. V. T. JACKSON, chairman of the section, presided and welcomed the large number of interested visitors.

The Florida Section, while relatively small in numbers, is rather proud of the consistently good attendance it has been able to maintain during the five years it has been organized. For example, at this meeting two members traveled a total distance of 600 miles each to attend; nine members each traveled a distance of 300 miles; four members traveled 120 miles each.

Indiana Section, A. C. S. The January meeting of the Indiana Section, A. C. S., was held on Friday, January 10th, at 8 P.M. DR. C. G. DERICK spoke on "The Truth about the Dye Industry."

Maine Section, A. C. S. *See* **University of Maine.**

Nebraska Section, A. C. S. *See* **University of Nebraska** and **Columbia University.**

Oklahoma Section, A. C. S. On Saturday, March 8, 1930, a meeting of the Oklahoma Section of the A. C. S. was held at the University of Oklahoma Medical School. The program consisted of the following papers: "New Methods of Calculating the Coefficient of Digestion as Applied to the Metabolism of the Fowl," by V. G. HELLER; "Some Sulfone Nitrogen Ring Compounds," BRUCE HOUSTON; "Ceramics in Oklahoma and Its Development," L. F. SHEERAR; "Present Tendencies in Science Teaching in Oklahoma," CLIFF R. OTTO.

Rhode Island Section, A. C. S. *See* **Brown University.**

University of Missouri Section, A. C. S. DR. S. C. LIND, director of the school of chemistry at the University of Minnesota, addressed this section of the A. C. S. at 2.30 o'clock, February 13th, in the lecture theater of the new chemistry building. The subject of his address was "Recent Developments in Chemical Kinetics of Gases."

DR. HERMAN SCHLUNDT, chairman of the department of chemistry, University of Missouri, entertained at luncheon in honor of Dr. Lind at the Tiger Hotel, his guests being the officers of University of Missouri Section.

Heart Beat Started by Radioactive Potassium. The potassium in the diet is the radioactive element which normally performs the vital function of starting the heart beat, it appears from experiments conducted in the laboratory of Dr. H. B. Zwaardemaker, professor emeritus of physiology at the University of Utrecht. These experiments have just been reported by Dr. Charles C. Lieb, professor of pharmacology at the College of Physicians and Surgeons, Columbia University, who has himself spent some time on research in Dr. Zwaardemaker's laboratory.

Earlier experiments of Dr. Zwaardemaker seem to have definitely established the fact that potassium is a radioactive element. The recent experiments have indicated that a radioactive element is essential in the initiation of the heart beat, and therefore an indispensable element of diet.

Pursuing these studies further Dr. Lieb will investigate the pharmaceutical value of radioactive spring waters, such as those found at Saratoga Springs, Arkansas Hot Springs, the Georgia Springs owned by Governor Roosevelt of New York, where infantile paralysis cases are treated, and many other famous spas throughout the country. For years it has been known that the waters of these springs were radioactive, but the active charges have been so small that leading radium authorities have considered their radioactivity a negligible quantity therapeutically.

Dr. Zwaardemaker's work, Dr. Lieb pointed out, not only indicates that the radioactivity of potassium is one-millionth to one-hundred-millionth that of radium, but that even this minute charge is essential to the maintenance of the heart beat.

"This may mean," said Dr. Lieb, "that even the very slight degree of radioactivity in the waters of famous spas is of distinct therapeutic value, although it is impossible for me to make any statement on the subject before extensive experimentation. Dr. Zwaardemaker discovered, however, that the radioactive elements uranium, polonium, thorium, and radium may replace potassium in some of the simpler processes of cell activity.

"In just what radioactive group potassium must be placed we have not determined. Probably that is the work of a physicist. But it does seem to be established that potassium gives off beta radiation. This is distinguished from alpha and gamma radiation as being in the order of the electron. Alpha radiation consists of helium atom nuclei, while gamma radiation is hard like X-rays.

"It is apparently the electrons from potassium atoms and their ionizing power that furnish the energy necessary in initiating the heart beat, but we are not yet prepared to discuss the mechanics of the process."

Dr. Lieb explained that the experiments consisted of the perfusion of the hearts of eels and frogs. When the hearts of these animals are taken out canulae, or small glass tubes, are attached to the blood vessels and fluid is passed through the hearts. The fluid does not contain potassium or other radioactive elements at first, and the heart ceases to beat in half an hour to an hour.

Potassium is then introduced into the liquid and the heart resumes its beat and continues to beat for about twenty-four hours. Similar results are obtained when instead of potassium another radioactive element is used. Not only did this physiological action lead to the conclusion that potassium was radioactive but measurements on specially constructed electrometers indicated that it gave off beta radiation.—*Science Service*

Recent Books

Gas Analysis. L. M. DENNIS AND M. L. NICHOLS, Cornell University. The Macmillan Company, New York, 1929. Revised edition. xix + 499 pages. 110 figures. 19.5 × 13 cm. $4.00.

The earlier edition of Dennis and Nichols' well-known book appeared in 1913. Since that time gas analysis has been developed considerably, and many new methods have appeared, and several old ones given way to more satisfactory procedures. Consequently, the appearance of this new edition should be welcomed, as this book is practically the sole representative of the field.

Beginning with a chapter on the collection and storage of gases, the development of the subject follows a logical order, and we find in turn considerations of measurement of gas volumes, reduction of volumes to standard conditions, determination of density, gas analysis over water, factors affecting the accuracy of analysis, the Hempel apparatus for analysis over mercury, combustion methods, properties of various gases, flue gas analysis, illuminating and fuel gas, the heating value of gas, atmospheric air, gas volumetric analyses, physical methods of gas analysis, and micro gas analysis. The appendix contains several tables of value to the analyst.

The chapter on physical methods of gas analysis is new, and deals with important methods based on interferometry, thermal conductivity of gases, and fractional distillation at low temperatures. Some of these subjects were mentioned in the older edition, but all are of such importance that they merit separate consideration.

Flue gas analysis and its significance are taken up far more in detail than in the earlier edition. The discussion of the practical use to which a flue gas analysis may be put is very good, and even more space might have been devoted to it. The chapter on heating value of gas is excellent, and the one dealing with combustion of gases is very well developed.

The reviewer notes with satisfaction that a discussion of "factors affecting the accuracy of analyses of gases" has been deemed a subject of sufficient importance for one chapter of the book. Certainly there is no field of chemical macro-analysis where the final results are any more dependent on the skill of the operator and his appreciation of these various "factors" than in gas analysis.

Printing, paper, and binding are of excellent quality, and this book should be well received at a time when manipulation and examination of gases is becoming more and more important.

NATHAN L. DRAKE
UNIVERSITY OF MARYLAND
COLLEGE PARK, MD.

The Making of Chemistry. JOHN HARROW. The John Day Co., New York, 1930. viii + 215 pp. 19.5 × 13 cm. $2.00.

This short account of the history and development of chemistry and chemical industry was written for the layman. The author has centered his recital around leading personalities and has emphasized important principles, discoveries, and achievements. The exposition and explanation of the significance of the hypotheses and their practical applications is necessarily non-technical. The author attempts to demonstrate "that 'abstract' research is the mother of every scientific advance, pure or applied, in the laboratory or in industry."

The reviewer used the experimental method and asked his wife, who qualifies as possessing no professional knowledge of chemistry, to read the book. Our impressions were quite similar. A surprisingly large number of persons are mentioned and many facts are set down, and yet the book is not an informing one.

The material is treated too superficially and it is spread so thin that there is hardly enough substance provided for the layman. The professional chemist, of course, reads much into the lines, but that isn't playing quite fair.

The book opens with the Stone Age and really closes with the latest applications of catalysis. The last chapter deals with chemistry in America. Almost everybody of note and a large proportion of the things of importance are given at least a line. The author has wisely appended a list of references for those whose appetites have been whetted. The reviewer frankly wonders how the lay mind reacts to such brief treatment of many of the topics.

The terse delineations of the political, economic, and literary conditions prevailing at some of the great milestones in chemical history are well done. Mr. Harrow is capable of better things. He knows his chemical history and he has a facile pen. May his next furrow be deeper and not quite so wide.

RALPH E. OESPER

UNIVERSITY OF CINCINNATI
CINCINNATI, OHIO

Handbook of Chemical Microscopy. Volume I. Principles and Use of Microscopes and Accessories. Physical Methods for the Study of Chemical Problems. EMILE MONNIN CHAMOT, B.S., Ph.D., Professor of Chemical Microscopy and Sanitary Chemistry, and CLYDE WALTER MASON, A.B., Ph.D., Assistant Professor of Chemical Microscopy, both of Cornell University. John Wiley and Sons, Inc., New York, 1930. xiii + 470 pp. 162 figures. 14.8 × 22.7 cm. $4.50.

This is the first volume of a two-volume publication, based on and intended to supersede the senior author's "Elementary Chemical Microscopy," which has been, since its publication in 1921, the main dependence of student, teacher, and practical worker in its field. The present work has been entirely rewritten, greatly expanded, and brought down to date. It will not only be read with pleasure but used with profit by the constantly growing number of chemists who realize the economy of time and material brought about by the use of chemical methods on a microscopical scale, augmented by optical measurements on small amounts of material which indicate chemical methods to be used in mass analysis or which corroborate data already obtained by such means.

Volume I as stated in the preface, has been confined to a discussion of optical principles, manipulative methods of general application, and the observation of physical and physico-chemical phenomena. Volume II, which is in course of preparation, will include chemical reactions as studied under the microscope, with particular reference to inorganic qualitative analyses, and with emphasis upon the time- and labor-saving features of the methods, rather than upon the sensitivity of the selected tests.

The text is based upon courses, both elementary and advanced, that have been given for a number of years, and that have been a mecca not only for research students but for practical workers in industrial laboratories. The first two chapters include a thorough discussion of the optical system of the microscope, and descriptions of special microscopes for different types of work. Chapters III to VI deal with light sources, the illumination of transparent and opaque objects, equipment and methods for the preparation of materials for microscopic study, observation of physical properties, and interpretation of appearances. Of especial interest are Chapters VII to X, on ultramicroscopy, photomicrography and microprojection, the study of doubly refracting materials by means of the polarizing microscope, and chemical crystallography. Chapters XI to XIII take up microscopic measurements, including refractive indices, particle-size determinations, and the quantitative analysis of heterogeneous mixtures. The appendix includes a list of reference books and journals on ap-

plied microscopy, and, of especial interest to teachers, a synopsis of laboratory practices in the introductory course in chemical microscopy at Cornell University, together with a key to materials provided for laboratory work.

The authors have drawn, not only from their own rich experience gained in years of teaching, research, and forensic work in this particular field, but from every possible source in the literature, producing a remarkably comprehensive survey of theory and practice in a very concise form. In addition to critical comments in the text, there are copious footnotes giving bibliographic references, and many well-chosen figures, most of them line drawings with a welcome absence of unnecessary detail.

The book presents a method of attack on problems of chemical analysis that is comparatively new to most chemists, but deserving of careful study on their part. The microscope has been considered as almost entirely the property of the biological laboratory. Even a cursory examination of the present volume should convince the most skeptical that here is a piece of apparatus that should be given at least as prominent a place in the chemical laboratory as the polariscope, and that students should be as carefully trained in its structure, care, and use as they are in the manipulation of an assay balance. It is hoped that the second volume will be forthcoming very shortly, as the completed publication will fill a unique and helpful position in the rapidly increasing literature of analytical chemistry.

V. A. PEASE

BUREAU OF CHEMISTRY AND SOILS
WASHINGTON, D. C.

Elementary Quantitative Analysis. CARL J. ENGELDER, Ph.D., Professor of Analytical Chemistry, University of Pittsburgh. John Wiley and Sons, Inc., New York City, 1929. xii + 254 pp. 8 figures, 16 tables. 15 × 23 cm. $2.75.

This book is a companion volume to the author's Elementary Qualitative Analysis. [*Compare* THIS JOURNAL, **5**, 903–4 (July, 1928).] It is written in such a manner as to indicate clearly a wide teaching experience in connection with the subject. It conveys the impression that a course in elementary quantitative analysis might be presented using this text with a minimum of effort on the part of the instructor in charge. Such might well be the case, however, with considerable undesirable influence upon a prospective student of advanced quantitative analysis with leanings toward research in the field. The author has been successful in his formulated intentions "in bringing together in one volume the theory, the laboratory practice and the calculations of quantitative analysis." "Classroom, laboratory, and self-instruction have been provided for by a careful selection of Procedures, Problems, and Review Questions. These, together with the theory, have been woven into a fabric of the text and closely correlated." In this estimate the term "elementary" should be stressed.

The text is divided into three parts. *Part I.* Fundamental Principles. *Part II.* Gravimetric Analysis. *Part III.* Volumetric Analysis. There are provided 8 laboratory determinations of gravimetric analysis in *Part II*, including a gas evolution analysis of a carbonate and the electrodeposition of copper. *Part III*, dealing with volumetric methods, is subdivided into four parts in order: Precipitation Reactions, Acidimetry, Oxidation and Reduction Methods, and Iodimetry. There are 8 laboratory determinations involved in *Part II*, distributed in the sections in the order given as follows: 1, 2, 3, and 2 each. The appendix contains the usual tables of reagents, supplies, and equipment, sample record pages, tables of density, periodic and atomic weight tables and a table of four-place logarithms.

The most striking characteristic of this text consists in the fact that one-fourth of the total content deals with the calculations, either explanatory or problem exercises. Another unusual feature is that

there is not a single reference to the literature of quantitative analysis with the exception of that to two textbooks at the beginning of Chapter IV. Both of these facts lend substantiation to the reviewer's comments in paragraph one above.

An elementary text in quantitative analysis fails greatly in its proper scope if the efforts toward brevity are obtained at the sacrifice of a complete treatment relative to common sources of error together with means for their prevention or eradication.

This holds in case of a failure to stress modifications in procedure to include determinations of a related nature. The author's failure to consider these facts may be illustrated in connection with the first gravimetric exercise given, the determination of sulfates. Common interfering substances such as nitrates, ferric salts, and alkali metal salts are not discussed. While similar procedures such as the determination of barium and lead as well as calcium and strontium are mentioned, the student might feel that sulfur present in the form of sulfate only can be determined by the method given. In this procedure the term colloid is applied to a finely divided barium sulfate precipitate and a reference to the discussion of the point of distinction given in the earlier portion of the text only fails to clear up the matter. The impression is left with the students that impurities in a barium sulfate precipitate (which may be the result of occlusion) are to be avoided because they are difficult to wash out of the precipitate (whereas it is impossible to do so). It is all very well that the theoretical points such as common ion effect be well applied to this determination but it is equally important that the practical difficulties and extended applications be equally emphasized.

The problem lists are in some cases incompletely covered by illustrative examples in the preliminary discussion. For example, the problems listed on page 51 give trouble because of the use of cases in which the common ion effect of added products having more than two ions formed by dissociation are incorporated without explanation being previously given of such an example. To be sure the better students will not be troubled by this failure. The point that such a situation is out of harmony with the general tenor of the text, however, still is apparent.

If the author's two texts, both the Qualitative and Quantitative, are to be companion course texts for successive application at the same institution there is considerable repetitive material. For example, compare the portions in the qualitative text on page 51 and subsequent pages on the topic "Balancing Equations of Oxidation-Reduction by Balance Changes" and "Balancing Equations of Oxidation-Reduction by Electron Transfers," as well as Tables V and VI, with the same material in the quantitative text page 180 and subsequent pages together with Tables VII and VIII. From the last-named table it might be inferred that series of oxidizing agents: $KClO$, $KClO_3$, $KClO_4$, and KIO_3 are of equal applicability, whereas under the same general conditions $KClO_4$ bears no resemblance.

An elementary text even should keep well up to date in the case of new apparatus, improved methods, and new reagents. In this regard developments have been practically ignored by the author, *Part III* being most deficient. Explanations based upon potentiometric applications should be omitted where no more completely treated than in this text. The section dealing with the electro-deposition of copper should have a more general treatment. The part dealing with iodimetry should emphasize the sources of error more.

It is strongly recommended that in the use of this text a carefully planned series of lecture discussions and illustrative demonstrations be supplied by the instructor in charge. By this plan only may the student use the material as pre-

sented in a manner to justify the time expended.

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The Essentials of Chemical Physiology. W. D. HALLIBURTON, M.D., LL.D., F.R.S., J. A. HEWITT, Ph.D., D.Sc., W. ROBSON, Ph.D., D.Sc. Twelfth edition. Longmans, Green & Co., 55 Fifth Ave., N. Y., 1929. xii + 383 pp. 56 illustrations. 1 colored plate. 14 × 21½ cm. $3.00.

Like the earlier editions this one consists of two parts, an elementary course in thirteen lessons (277 pages) and an advanced course in seven lessons (74 pages). The book is intended to serve as a "practical guide."

The elementary course is of the combined laboratory manual and textbook types, the first part of each lesson being devoted to laboratory exercises of which all but four are qualitative. A very large number of subjects are covered in the text making the discussion of each in so small a volume necessarily very brief. The treatment is inclined to be dogmatic as is perhaps inevitable with such condensed material. Theoretical discussions and the consideration of controversial matters have been cut almost to the vanishing point.

Graphic formulas though not numerous are correct in all cases except one, obviously an oversight, in the formula for methyl glucoside on page 62. The formula for kynurnic acid (p. 264) and the reversal of formulas for glucose and glucosides occurring on pages 62 and 63 may be confusing to the student.

The advanced course consists altogether of laboratory work and presents a good assortment of quantitative methods. No attempt is made in this part to give a theoretical background.

The book has been well reworked and brought up to date although some old material, such as the hypobromite method for urea, which might have been discarded, has been retained.

The authors make a distinction between chemical physiology and physiological chemistry, no doubt as a justification for the unusual title, which they later nullify by the assertion that the book deals with both fields.

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UNIVERSITY, MISSISSIPPI

Select Methods of Metallurgical Analysis. WILLIAM ARCHIBALD NAISH, Ph.D. (Eng.), A.R.S.M., B.Sc., F.I.C., M. Inst.M.M., Lecturer in Metallurgy, Chelsea Polytechnic, London, and JOHN EDWARD CLENNELL, B.Sc. (London), Assoc. Inst. M.M. John Wiley & Sons, Inc., New York City, 1930. xii + 495 pp. 24 × 15 cm. Figures 32. $7.50.

The object of this book is the compilation of selected methods of analysis of both the ordinary and rarer elements chosen for their suitability and accuracy, useful for professional metallurgists, chemists, and students. The book is self contained in that its Parts I–VI include sampling, qualitative analysis and general methods of solution and separation; the analysis and dry assay of the individual elements; commercial metals and alloys; ores, slags, and drosses; refractory materials and the proximate analysis of coal; minerals, electrometric titrations, and spectrographic methods.

The system of qualitative analysis is largely in table form and includes the rarer elements. Trouble may be encountered by the inexperienced; for example, "Group I is precipitated by HCl." The book conforms to the British and Colonial usage of red lead in the fire assays and the I.M.M. screen standards in sieves. Briefness of description makes many of the quantitative procedures suitable only for the experienced chemist. In the decomposition of white metals with H_2SO_4, separated S is not eliminated previous to the $KMnO_4$ titration for Sb. Ni is recommended as a reducing agent in the iodide method for Sn but iron nails with a hydrocarbon blank is still given as an alternative. The

much cleaner and more accurate reduction with Pb is not considered. It is illogical to advocate the removal of Ni before the titration and not Fe. As_2O_3 is recommended for standardization of iodine because of the time required to dissolve pure Sn in HCl. Why not make use of its quick solubility in concentrated H_2SO_4? In the analysis of commercial Pb, apparently Bi is assumed to be absent. The chapter on electrometric methods is brief, Hildebrand's apparatus being the only one considered.

Each chapter is followed by its bibliography with a unique grouping of the references under headings which give an outline of the procedure. The total bibliography consists of about 3000 references covering seventy journals and numerous standard texts.

The book is particularly free from typographical errors and is well printed. It is not recommended for student use except as a reference. With its enormous bibliography, it should be in every college library. It will appeal to all those who are actively interested in a diversity of analytical work.

CROSLEY F. BAKER

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BULLETINS

Grading in Industrial Schools and Classes. M. M. PROFFITT, Specialist in Industrial Education. U. S. Dept. of the Interior, *Industrial Education Circular No. 28*, Dec., 1929. U. S. Govt. Printing Office, Washington, D. C. 20 pp. $0.05.

This pamphlet contains a general discussion of the grading situation and an annotated general bibliography on grading is included.

Bile-Calmette-Guerin as Preventive Vaccine against Tuberculosis. By cultivating the tubercle bacillus through a long series of generations on a bile medium, Calmette, in association with Guerin, has succeeded in rendering the organism non-virulent though still possessing protective and immunizing powers. A preparation containing this modified tubercle bacillus under the name B.C.G. (that is, "Bile-Calmette-Guerin") is now being tested on the large scale as a preventive vaccine against tuberculosis both in man and in animals. According to reports which have appeared in the daily press, Prof. Cantacuzene, of Bucharest, has carried out tests with this preparation in Rumania during the past three years, involving the inoculation of 17,535 persons, which incontrovertibly show the value of the preparation. Out of more than 1000 children living in surroundings favorable to the development of tuberculosis who had been vaccinated, not a single case had been recorded, and no ill effect had followed vaccination or re-vaccination with B.C.G.

In Australia, Prof. Woodruff and Mr. Gregory have carried out experimental work with the B.C.G. vaccine as a preventive of tuberculosis in cattle (*Jour. of the Council for Scientific and Industrial Research*, **2**, 1929, p. 137; Melbourne: H. J. Green). A number of calves were inoculated with amounts of B.C.G. up to 100 mgm. None of the animals showed any ill effects, the only lesion produced being a small nodule which in course of time generally disappeared. Twenty vaccinated calves were afterward tested by intravenous inoculation of virulent tubercle bacilli to determine their resistance toward virulent infection. Six of these animals died as a result of extensive tuberculosis in about the same time as unvaccinated control animals. The remaining fourteen showed some clinical symptoms but later became normal, and on slaughter, although some lesions of tuberculosis were found, in the majority these did not appear to be progressing. It is concluded that B.C.G. vaccination confers some degree of resistance toward infection with virulent tubercle bacilli.—*Nature*

LIST OF PERIODICALS ABSTRACTED BY THE JOURNAL OF CHEMICAL EDUCATION

On compiling this list of 250 periodicals, our original intention was to include only those from which articles had actually been abstracted for THIS JOURNAL during its six years' existence. However, in addition to these publications, we have included several others recently brought to our attention which will possibly occasionally furnish suitable material for our Abstract Section. We realize this list is by no means complete but hope that fact will not impair its usefulness. We would appreciate being advised of any corrections, additions, or omissions which should be made. We have been guided largely by the "List of Periodicals Abstracted by *Chemical Abstracts*"[1] in the type of information selected and the arrangement of this material. The periodicals are arranged alphabetically according to their authorized abbreviations. These abbreviations will be found on pages 958–9. In the case of societies, academies, etc., the names of whose publications begin with "Bulletin," " Journal," "Proceedings," "Transactions," etc., and which consequently might be obscured, the name of the institution is indexed in addition to the complete title.

For each periodical the following information, in so far as we have been able to obtain it, is given:

1. **Title**—Complete as it appears on the periodical.

2. **Abbreviation**—The letters which constitute the authorized abbreviations used in the abstracts are printed in bold-face type.

3. **Frequency of Appearance**—The following symbols are used: *a* annual, *sa* semiannual, *q* quarterly, *bm* bimonthly, *m* monthly, *sm* semimonthly, *bw* biweekly, *w* weekly, *sw* semiweekly, *irr* irregular. For those periodicals published during a portion of the year only, the names of the months of publications, inclusive, have been placed in parentheses immediately following the frequency. The abbreviations of the months used are: Ja, F, Mr, Ap, My, Je, Jy, Ag, S, O, N, D.

4. **Volumes per Year**—If the number of volumes per year is other than one, this information immediately follows item **3.**

5. **1930 Volume Number**—The volume number of the first issue in 1930 is given in bold-face type. If this information was not obtainable the year for which the volume number is given is included in bold-face type in parentheses.

6. **Issue Number**—If the first issue of 1930 is not number 1 of the volume, its number is given in parentheses immediately following item **5.**

7. **Price in United States**—Prices in parentheses are for single numbers; prices not so enclosed are for *a year's subscription in the United States* unless otherwise stated. An asterisk is used in those cases where members of some organization enjoy special rates. Abbreviations

[1] *Chemical Abstracts*, A. C. S., Ohio State University, Columbus, Ohio, **1926.**

for coins used in various countries are: d—penny, f—florin, F—franc, K—Danish kroner, L—lira, £—pound, M—markka (Finnish), Rm—reichsmark, s—shilling, Y—yen, z—zloty.

8. Publishers—The name and address of the publisher or person to whom inquiries and orders are to be sent is given in italics.

Examples

I. Scientific Monthly, The—. *m* 2 vols. **30**(172). $5.00. *The Science Press, Grand Central Terminal, N. Y. C.*

1. **Title**—The Scientific Monthly.
2. **Abbreviation**—Sci. Mo.
3. **Frequency of Appearance**—Monthly.
4. **Volumes per Year**—Two volumes.
5. **1930 Volume Number**—The first volume in 1930 is 30.
6. **Issue Number**—The first issue in 1930 is number 172.
7. **Price in United States**—Subscription per year is $5.00.
8. **Publishers**—Subscriptions may be sent to *The Science Press, Grand Central Terminal, N. Y. C.*

II. Hormone, The—. *m* (O–My). **4.** $2.00. *Dept. of Chemistry, Holy Cross College, Worcester, Mass.*

3. **Frequency of Appearance**—Published monthly October to May, inclusive.

The response and coöperation of the publishers in this undertaking has indeed been gratifying and we wish to take this opportunity to express our sincerest appreciation of their assistance both in furnishing us the information requested and in checking proof.

Authorized Abbreviations

The abbreviations listed herewith are those used in the Abstract Section of THIS JOURNAL. The abbreviations are printed in bold-face type and foreign words are printed in italics.

Abstr. Abstracts
Acad. Academy
Admin. Administration
Agr. Agricultural
Akad. *Akademie*
Ala. Alabama
Am. American
Analyt. Analytical
angew. *angewandte*
App. *Apparatur*
Assoc. Association

Ber. *Berichte*
Biochem. Biochemical, *Biochemische*
Biol. Biological
biol. *biologischen*
Bull. Bulletin

Calif. California
Can. Canadian
cechoslovak. *cechoslovakischen*
Cent. Central
Chem. Chemical, Chemicals, *Chemiczny, Chemie, Chemiker, Chemisch, Chemische,* Chemistry
chem. *chemischen*
Chi. Chicago
Chim. *Chimica, Chimie*
chim. *chimica, chimique, chimiques*
Chron. Chronicle
Clin. Clinical
Coll. Colleges

deut. *deutscher*

Econ. Economics
Ed. Edition
Educ. Education, Educational
Elec. Electric, Electrical
Electrochem. Electrochemical
Eng. Engineering, Engineers, England
Ernähr. *Ernährung*
Exec. Executives
Exper. Experimenter

Farm. *Farmaci*
Fla. Florida

Gen. General
Geog. Geographic
geol. *geologischer*
Giorn. *Giornale*

Helv. *Helvetica*
Hist. Historical

Ill. Illinois
Ind. Indiana, Industrial, *Industrie*, Industry
ind. *industriale*
Ing. *Ingenieure*
Inst. Institute, Institution
Inv. Invention

J. Journal

Kem. *Kemisk*
Klin. *Klinische*

Lebensm. *Lebensmittel*

Mag. Magazine
Math. Mathematics
Med. Medical, Medicine
Medd. *Meddelanden*
Met. Metallurgical, Metallurgy
Mich. Michigan
Miss. Mississippi
Monat. *Monatshefte*
Mo. Monthly

N. Y. New York
Natl. National
Naturw. *Naturwissenschaften*
Neb. Nebraska
Nev. Nevada

Okla. Oklahoma

Ore. Oregon
Org. Organic

Pädagog. *Pädagogische*
Penna. Pennsylvania
Pharm. Pharmaceutical, Pharmacy
Phil. Philosophical
Phys. Physical,
phys. *physique*
physik. *physikalische*
Pract. Practical
preuss. *preussischen*
Proc. Proceedings
Profs. Professors
Progr. Progress, Progressive
Psychol. Psychology

Quart. Quarterly

Rec. *Recueil*
Rep. Report
Reptr. Reporter
Rev. Review, *Revue*
Roy. Royal

Sch. School, Schools
Sci. Science, Scientific
sci. *scientifique*
Sec. Secondary
Sitzb. *Sitzungsberichte*
Soc. *Société*, Society
St. Street
Superv. Supervision
Syn. Synthetic

Tech. Technology
Tid. *Tidskrift*
Trans. Transactions
trav. *travaux*

Univ. Universities, University
Untersuch. *Untersuchung*

Va. Virginia
Ver. *Vereins*

Wash. Washington
Wiss. *Wissenschaften*
Wochschr. *Wochenschrift*

Z. *Zeitschrift*
Ztg. *Zeitung*
Zuckerind. *Zuckerindustrie*

Periodicals

Accelerator, The—. *m* (O–Je). **14**(4). *A. N. Stevens, Adv. Mgr., Eli Lilly & Co., Indianapolis, Ind.*

Alabama School Journal. *m* (S–My). **48.** $1.00. *Frank L. Grove, 417 First National Bank Bldg., Montgomery, Ala.*

American Annual of Photography. *a.* $1.75. *G. Murphy, 57 E. Ninth St., N. Y. C.*

American Association of University Professors, Bulletin of—. See **Bulletin of,** etc.

American Chemical Society, Journal of the—. See **Journal of the,** etc.

American Education (merged with **Education,** which see).

American Educational Digest (now **School Executives Magazine,** which see).

American Electrochemical Society, Transactions of the—. See **Transactions of the,** etc.

American Food Journal, The—. (Now **Practical Home Economics,** which see.)

American Institute of Chemical Engineers, Transactions of the—. See **Transactions of the,** etc.

American Journal of Botany. *m* (O–Jy). **17.** $7.00. *Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, N. Y.*

American Journal of Pharmacy. *m.* **102.** $3.00. *American Journal of Pharmacy, 43d St. and Kingsessing Ave., West Philadelphia, Penna.*

American Journal of Science, The—. *m* 2 vols. **19**(109). $6.00. *New Haven, Conn.*

American Magazine. *m* 2 vols. **109.** $2.50. *Crowell Publishing Co., Springfield, Ohio.*

American Medical Association, The Journal of the—. See **Journal of the,** etc.

American Mercury, The—. *m* 3 vols. **19**(73). $5.00. *730 Fifth Ave., N. Y. C.*

American Pharmaceutical Association, Journal of—. See **Journal of the,** etc.

American Review (discontinued 1926). *Bloomington, Ill.*

American School Board Journal. *m* 2 vols. **80.** $3.00. *354 Milwaukee St., Milwaukee, Wis.*

Analyst, The—. *m.* **55**(646). 30s.* *W. Heffer & Sons, Ltd., 4 Petty Cury, Cambridge, England.*

Annual Reports on the Progress of Chemistry. *a.* **26.** 11s, post-free. *The Chemical Society, Burlington House, London, W. 1, England.*

Association of American Colleges Bulletin. 4 nos. per yr. **16.** $3.00. *Robert L. Kelly, Editor, 111 Fifth Ave., N. Y. C.*

Association of American Medical Colleges, Journal of the—. See **Journal of the,** etc.

Association of American Universities: Journal of Proceedings. *a.* **31.** $0.75. *University of Chicago Press, 5750 Ellis Avenue, Chicago, Ill.*

Atlantic Monthly, The—. *m* 2 vols. $4.00. *8 Arlington St., Boston, Mass.*

Berichte der deutschen chemischen Gesellschaft. *irr.* (about *m*). **63.** Rm73. *Deutschen chemischen Gesellschaft, Sigismundstr. 4, Berlin, W. 10, Germany.*

Biochemical Journal, The—. *bm.* **24.** $15.00. *University of Chicago Press, Chicago, Ill.*

Biochemische Zeitschrift. *m* 12 vols. **217.** Rm28. *Julius Springer, Link-Str. 23–24, Berlin, W. 9, Germany.*

Bulletin of the American Association of University Professors. *m* (O–My). **16.** $2.50.* *26 Jackson Place, Washington, D. C.*

Bulletin of the Association of American Medical Colleges (now **Journal of the Association of American Medical Colleges**, which see).

Bulletin of the Institute of Physical and Chemical Research (Tokyo) (Rikwagaku Kenkyujo Iho). *m.* **9.** Y6. *Iwanami Shoten, 16 Minami-Jimbocho, Kanda-Ku, Tokyo, Japan.*

Bulletin de la société chimique de France. *m* 2 vols. issued simultaneously. **47** and **48.** *44 Rue de Rennes, Paris (6e), France.*

Business Chemistry. *Irr.* **5.** Gratis. *Skinner, Sherman & Esselen, Inc., 246 Stuart St., Boston, Mass.*

California Quarterly of Secondary Education. 4 nos. per sch. yr. **5**(2). $3.00.* *California Society of Secondary Education, 2163 Center St., Berkeley, Calif.*

Canadian Chemistry and Metallurgy. *m.* **14.** $3.00. *Westman Publications, Ltd., 366 Adelaide St. West, Toronto 2, Ontario, Canada.*

Catalyst, The—. *m* (S–Je). **15.** $1.00. *J. Howard Graham, 7 Cliveden Ave., Glenside, Penna.*

Catalyzer, The—. *m* (O–Je). **7** (4). $1.00. *The Dept. of Chemistry, Univ. of Notre Dame, Notre Dame, Ind.*

Catholic Educational Review. *m* (S–Je). **28.** $3.00. *Catholic Educational Press, 1326 Quincy St., N. E., Washington, D. C.*

Chemical Abstracts. *sm.* **24.** $7.50.** *American Chemical Society, Mills Building, Washington, D. C.*

Chemical Age (London), The—. *w* 2 vols. **22**(549). 26s. *Benn Brothers, Ltd., Bouverie House, 154 Fleet St., London, E. C. 4, England.*

Chemist Analyst, The—. *bm.* **19.** Gratis. *J. T. Baker Chemical Co., Phillipsburg, N. J.*

Chemische Apparatur. *sm.* **17.** Rm 6.50. *Otto Spamer, Heinrichstr. 9, Leipzig, C 1, Germany.*

Chemical Bulletin (Chicago), The—. *m.* **17.** $1.00.* *556 W. Jackson Blvd., Chicago, Ill.*

Chemische Fabrik, Die—. (**Teil B** of **Zeitschrift des Vereins deutscher Chemiker.**) *w.* **3.** Rm 37. *Verlag Chemie, G. m. b. H., Berlin, W. 10, Germany.*

Chemistry & Industry (Published under same cover with **Journal of the Society of Chemical Industry**). *w.* **49.** $20.40. *Central House, 46–47 Finsbury Square, London, E. C. 2, England.*

Chemistry Leaflet, The—. 34 nos. per sch. yr. **3** (15). $2.00. *Wm. W. Buffum, 654 Madison Avenue, N. Y. C.*

Chemical Markets (formerly **Drug and Chemical Markets**). *m* 2 vols. **26.** $2.00. *Chemical Markets, Inc., 25 Spruce St., N. Y. C.*

Chemical & Metallurgical Engineering. *m.* **37.** $3.00. *McGraw-Hill Publishing Co., Inc., 10th Ave. at 36th St., N. Y. C.*

Chemical News and Journal of Industrial Science, The—. *w* 2 vols. **140**(3638). $7.50. *Chemical News, Ltd., Merton House, Salisbury Sq., London, E. C. 4, England.*

Chemical Reviews. *q.* **7.** $5.00.* *The Williams & Wilkins Co., Mt. Royal and Guilford Aves., Baltimore, Md.*

Chemical Warfare. *m* (S–Jy). **16.** Intended for official use. *The Chemical Warfare School, Edgewood Arsenal, Edgewood, Md.*

Chemisch Weekblad. *w.* **27.** f15. *D. B. Centen, O. Z. Voorburgwal 115, Amsterdam, Holland.*

Chemiker-Zeitung. 3 times a week. **54.** Rm 48. *Walter Roth, Cöthen, Germany.*

Chemical Society of France—see **Bulletin de la société chimique de France.**

Chemical Society of London—see Journal of the **Chemical Society**.

Chemicals. *w* 2 vols. **33.** $5.00. *"Chemicals," 51 Vesey St., N. Y. C.*

Chemist and Druggist, The—. *w* 2 vols. **112.** 20s. *28 Essex Street, Strand, London, W. C. 2, England.*

Chicago Schools Journal. *m* (S–Je). **12**(5). Gratis to Chi. teachers. *Chicago Normal College, 6800 Stewart Ave., Chicago, Ill.*

Chimie & Industrie. *m* 2 vols. **23.** F500. *Société de chimie industrielle, 49 rue de Mathurins, Paris, France.*

China Journal, The—. (Formerly **China Journal of Science and Arts;** name changed 1925.) *m.* **12.** $6.00. *The Secy., 8 Museum Rd., Shanghai, China.*

China Journal of Science and Arts. (Now The **China Journal**, which see.)

Clinical Medicine and Surgery. *m.* **37.** $3.00. *American Journal of Clinical Medicine, Inc., N. Chicago, Ill.*

Collection of Czechoslovak Chemical Communications. *m.* **2.** $5.00. *International Art & Science Book Co., 192 Broadway, N. Y. C.*

Colliers, The National Weekly. *w.* $2.00. *P. F. Collier and Sons Co., Springfield, Ohio.*

Compressed Air Magazine. *m.* **35.** $3.00. *11 Broadway, N. Y. C.*

Contributions to Education, Teachers College Series. *irr.* $1.50. *Teachers College Bureau of Publications, Columbia Univ., N. Y. C.*

Cornell Chemist. (Discontinued about 1925.) *Cornell University, Dept. of Chem., Ithaca, N. Y.*

Cornell Rural School Leaflet. 4 nos. per sch. yr. **23**(3). Gratis to N. Y. rural teachers. *E. Laurence Palmer, Cornell University, Ithaca, N. Y.*

Crucible, The—. *m* (S–Je). **13**(5). $1.00.* *H. H. Craver, Pittsburgh Testing Laboratory, Stevenson and Locust Sts., Pittsburgh, Penna.*

Czechoslovak Chemical Communications, Collection of—. See **Collection of,** etc.

Dansk Tidskrift for Farmaci. *m.* **4.** K12. *Danmarks farmaceutiske Lelskab, Stockholmsgade 27–9, Copenhagen, Denmark.*

Discovery. *m.* **10**(121). 12s 6d. *Benn Brothers, Ltd., Bouverie House, Fleet St., London, E. C. 4, England.*

Drug and Chemical Markets (now **Drug Markets and Chemical Markets,** which see).

Drug Markets (formerly **Drug and Chemical Markets**). *m* 2 vols. **24.** $2.00. *Drug Markets, Inc., 25 Spruce Sts., N. Y. C.*

Du Pont Magazine, The—. *m.* **24.** $1.00. *E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.*

Dyer Calico Printer, Bleacher, Finisher and Textile Review. *sm* 2 vols. **63.** 12s 6d. *Heywood & Co., Ltd., Drury House, Russell St., Drury Lane, London, W. C. 2, England.*

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Ecology. *q.* **11.** $4.00. *Brooklyn Botanic Garden, 1000 Washington Avenue, Brooklyn, N. Y.*

Educational Administration and Supervision. *m* (O–Je). **16.** $4.00. *Warwick & York, Inc., Baltimore, Md.*

Educational Method. *m*(O–Je). **9.** $3.00. *Educational Method, 525 West 120th St., N. Y. C.*

Educational Record, The—. *q.* **11.** $2.00. *The American Council on Education, 26 Jackson Place, N. W., Washington, D. C.*

Educational Research Bulletin. *bw* (S–My). **9.** Gratis. *The Ohio State University, Columbus, Ohio.*

Educational Review (now combined with **School & Society**). Last issue published separately in October, 1928. *The Science Press, Grand Central Terminal, N. Y. C.*

Educational Screen. *m* (S–Je). **9.** $2.00. *5 S. Wabash Ave., Chicago, Ill.*

Education (now includes **American Education**). *m* (S–Je). **50**(5). $4.00. *Pubs. of Education, 120 Boylston St., Boston, Mass.*

Education Outlook, The—. *m.* **7.** $2.50. *The Education Outlook, 23 Southampton St., Bloomsbury Square, London, W. C. 1, England.*

Educational Outlook. 4 nos. per sch. yr. **5.** $1.25. *School of Education, Univ. of Pennsylvania, Philadelphia, Penna.*

Electrical Experimenter (now **Science & Invention**, which see).

Engineering and Mining Journal (to be radically changed after January 1, 1930). *w* 2 vols. **127 & 128 (1929).** $6.00. *McGraw-Hill Pub. Co., Inc., 10th Ave. at 36th St., N. Y. C.*

Ernährung der Pflanze. *sm.* **26.** Rm2. *Deutschen Kalisyndicat, G. m. b. H., Berlin, S. W. 11, Germany.*

Explosives Engineer. *m.* **8.** $1.00. *The Explosives Engineer, Wilmington, Del.*

Finska Kemistsamfundets Meddelanden. 4 nos. per yr. **34(1925).** *Helsingfors, Finland.*

Florida Educational Association, Journal of the—. See **Journal of the,** etc.

Forum. *m* 2 vols. **83.** $2.50. *Subscription Dept., 441 Lexington Ave., N. Y. C.*

General Electric Review. *m.* **33.** $3.00. *General Electric Co., Schenectady, N. Y.*

General Magazine and Historical Chronicle, The—. *q.* $4.00. *General Alumni Society, Univ. of Pennsylvania, 19th and Federal Streets, Camden, N. J.*

General Science Quarterly (now **Science Education**, which see).

Genetics. *bm.* **15.** $6.00. *Brooklyn Botanic Garden, 1000 Washington Ave., Brooklyn, N. Y.*

Giornale di chimica industriale ed applicata. *m.* **12.** L100.* *Via S. Paolo 10, Milan (3), Italy.*

Glass Container, The—. *m.* 9(3). $1.50.* *Norman E. White, The Glass Container Association of America, 19 West 44th St., N. Y. C.*

Glass Industry, The—. *m.* **11.** $2.00. *Glass Industry Publishing Co., Inc., 50 Church St., N. Y. C.*

Golden Book Magazine. *m.* **11.** $3.00. *Rev. of Reviews Corp., 55 Fifth Ave., N. Y. C.*

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Harpers Magazine. *m* 2 vols. **160**(2). $4.00. *Harper & Brothers, 49 E. 33rd St., N. Y. C.*

Harvard Alumni Bulletin. *w* (O–Je). **32.** $4.00. *1400 Massachusetts Ave., Cambridge, Mass.*

Harvard Graduates' Magazine. *q.* **38.** $4.00. *Henry S. Thompson, 60 State St., Boston, Mass.*

Helvetica Chimica Acta. 6 to 8 nos. per yr. **13.** F (Swiss) 35. *Georg & Co., Basel, Switzerland.*

Hexagon of Alpha Chi Sigma, The—. *m* (O–My). **20**(4). $3.00.* *450–54 Ahnaip Street, Menasha, Wis.*

High School Journal. *m* (O–My). **13.** $1.50. *I. C. Griffin, Business Manager, Chapel Hill, N. C.*

High School Quarterly, The—. *q.* **18**(2). $1.00. *J. S. Stewart, Editor & Publisher, Athens, Ga.*

High School Teacher, The—. *m* (S–Je). **6.** $2.00. *Wright and Main Sts., Blanchester, Ohio.*

Hormone, The—. *m* (O–My). **4.** $2.00. *Dept. of Chemistry, Holy Cross College, Worcester, Mass.*

Hygeia, The Health Magazine. *m.* $3.00. *Am. Med. Assoc., 535 N. Dearborn St., Chicago, Ill.*

Illinois **Academy of Science, Transactions** of the—. See **Transactions** of the, etc.

Illinois **Teacher.** *m* (S–Je). **19.** $2.00. *R. C. Moore, Carlinville, Ill.*

Inco. *q.* **10**(4). Gratis. *International Nickel Co., Inc., 67 Wall St., N. Y. C.*

India Rubber Journal, The—. *w* 2 vols. **80.** 20s. *37 & 38 Shoe Lane, Fleet St., London, E. C., England.*

India Rubber World. *m* 2 vols. **83.** $3.00. *India Rubber World, Federated Bus. Pub. Inc., 420 Lexington Ave., N. Y. C.*

Indiana **Academy of Science, Proceedings** of the—. See **Proceedings** of the, etc.

Industrial and **Engineering Chemistry**. *m.* **22.** $7.50.* *American Chemical Society, Mills Bldg., Washington, D. C.*

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Industrial and **Engineering Chemistry, News Edition.** *bm.* **8.** $1.50.* *American Chemical Society, Mills Building, Washington, D. C.*

Indicator, The—. *m* (O–Je). Bull. N. Y. & North Jersey A. C. S. Sections. *52 E. 41st St., N. Y. C.*

Industrie chimique, L'—. *m.* **17**(192). F80. *L'Industrie chimique, 8 Rue de Miromesnil, Paris (8e), France.*

Institute of Metals, Journal of—. See **Journal** of, etc.

Institute of Physical and **Chemical Research, Bulletin** of the—**(Tokyo)**. See **Bulletin** of the, etc.

Institution of the **Rubber Industry, Transactions** of the—. See **Transactions** of the, etc.

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Isis (International Review Devoted to the History of Science and Civilization). *q* 1 or 2 vols. **14.** $6.00.* *F. E. Brasch, Secretary, Library of Congress, Washington, D. C.*

Isotopics. *m* (O–Je). **6** (4). A. C. S. Regional Bull. of Ohio, Michigan, Lexington, Ky., Kanawha Valley, W. Va., and Erie, Penna. *John D. Morron, Mechanical Rubber Co., Cleveland, Ohio.*

Journal of **Agricultural Research.** *sm* 2 vols. **40.** $4.00. *Supt. of Documents, Govt. Printing Office, Washington, D. C.*

Journal of the **American Chemical Society,** The—. *m.* **52.** $7.50.* *American Chemical Society, Mills Building, Washington, D. C.*

Journal of the **American Medical Association,** The—. *w* 2 vols. **94.** $7.00. *Am. Med. Assoc., 535 N. Dearborn St., Chicago, Ill.*

Journal of the American Pharmaceutical Association. *m.* **19.** $4.00. *10 W. Chase St., Baltimore, Md.*

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Journal of the Association of American Medical Colleges (formerly Bulletin of the Association of American Medical Colleges). *bm.* **5.** $3.00. *Fred. C. Zapffe, Editor, 25 E. Washington St., Chicago, Ill.*

Journal of Biological Chemistry. *m* 4 or 5 vols. **85**(2). $5.00 per vol. *Mt. Royal and Guilford Aves., Baltimore, Md.*

Journal of the Chemical Society (London). *m.* **1930.** £3.30. *The Chemical Society, Burlington House, London, W. 1, England.*

Journal de chimie physique. *m.* **27.** $4.00. *Aux presses universitaires de France, 49 Boulevard St.-Michel, Paris (Ve), France.*

Journal of Education. *w* (S–Jy), 2 vols. **111.** $3.00. *6 Beacon St., Boston, Mass.*

Journal of Educational Psychology, The—. *m* (S–My). **21.** $5.00. *Warwick & York, Inc., Baltimore, Md.*

Journal of Educational Research. *m* (S–Je), 2 vols. **21.** $4.00. *Public School Publishing Co., Bloomington, Ill.*

Journal of Education, The—. *m.* **62**(726). 8s. *Wm. Rice, 3 Ludgate Broadway, London, E. C. 4, England.*

Journal of Engineering Education, The—. *m* (S–Je). **21.** $3.00. *F. L. Bishop, University of Pittsburgh, Pittsburgh, Penna.*

Journal of the Florida Educational Association. *m* (O–Je). **7**(4). $2.00. *Hodges Bldg., Tallahassee, Fla.*

Journal of the Franklin Institute. *m* 2 vols. **209.** $6.00. *Controller, The Franklin Institute, 15 S. 7th St., Philadelphia, Penna.*

Journal of Higher Education, The—. *m* (S–Jy). **1.** $3.00. *Bureau of Education Research, Ohio State University, Columbus, Ohio.*

Journal of Home Economics, The—. *m.* **22.** $3.00. *101 E. 20th St., Baltimore, Md.*

Journal of Institute of Metals. *sa* 2 vols. **37.** £3 3s. *36 Victoria St., London, S. W. 1, England.*

Journal of the National Education Association, The—. *m* (O–Je). **19.** $2.00. *1201 Sixteenth St., N. W., Washington, D. C.*

Journal of the Optical Society of America and Review of Scientific Instruments. (Beginning Jan. 1, 1930, two journals: The Journal of the Optical Society of America, and The Review of Scientific Instruments, which see.)

Journal of the Optical Society of America, The—. (Formerly part of the Journal of the Optical Society of America and Review of Scientific Instruments.) *m.* **20.** $4.00. *F. K. Richtmyer, Managing Editor, Cornell Univ., Ithaca, N. Y.*

Journal of Physical Chemistry, The—. *m.* **34.** $10.00. *Wm. W. Buffum, 654 Madison Ave., N. Y. C.*

Journal of the Royal Society of Arts. *w.* **79.** $0.30 per copy. *G. Bell & Sons, Ltd., York House, Portugal St., London, W. C. 2, England.*

Journal of Scientific Instruments. *m.* **7.** 30s. *Cambridge University Press, Fetter Lane, London, E. C. 4, England.*

Journal of the Society of Chemical Industry (London). *w.* **49.** $20.40. *Central House, 46 and 47 Finsbury Sq., London, E. C. 2, England.*

Journal of the Society of Dyers and Colourists. *m.* **46.** £3. *The Society of Dyers and Colourists, Pearl Assurance Bldgs., Market St., Bradford, England.*

Kalends, The—. *m.* **9.** Gratis. *The Williams & Wilkins Co., Baltimore, Md.*

Klinische Wochenschrift. *w.* **9.** Rm34. *Hirschwaldsche Buchhandlung, Unter den Linden 68, Berlin, N. W. 7, Germany.*

Laboratory, The—. *bm* (S–My). **3.** Gratis. *Technical Service Dept. of Fisher Scientific Co., Pittsburgh, Penna.*

Ladies' Home Journal. *m.* **47.** $1.00. *Curtis Publishing Co., Independence Square, Philadelphia, Penna.*

Latin Notes. 8 nos. per yr. **7.** $1.00. *Columbia University, Teachers' College, Service Bureau for Classical Teachers, N. Y. C.*

Library Journal, The—. 22 nos. per yr. **55.** $5.00. *R. R. Bowker Co., 62 W. 45th St., N. Y. C.*

Living Age, The—. *sm* 2 vols. **337**(4353). $6.00. *253 Broadway, N. Y. C.*

Magazine of Wall Street, The—. *bw* 2 vols. **45**(5). $7.50. *Ticker Publishing Co., Inc., 42 Broadway, N. Y. C.*

McGraw-Hill Book Notes. *irr.* Gratis. *McGraw-Hill Book Co., Inc., 370 Seventh Ave., N. Y. C.*

Medical Progress. (Publication suspended Jan., 1930.) *Medical Progress Co., Louisville, Ky.*

Metal Industry, The—. (**New York**). *m.* **28.** $2.00. *The Metal Industry Publishing Co., 99 John St., N. Y. C.*

Metals & Alloys. *m.* **1.** $3.00. *The Chemical Catalog Co., Inc., 419 Fourth Ave., N. Y. C.*

Metan (now **Przemsyl Chemiczny**, which see). **Metan** existed 1917–19.

Michigan Alumnus. *w.* **36.** $4.00. *Alumni Assoc. of Univ. of Mich., Ann Arbor, Mich.*

Michigan Education Journal. *m* (S–Je). **7.** $2.00. *Mich. Educ. J., Michigan Education Association, Lansing, Mich.*

Military Surgeon. *m* 2 vols. **66.** $4.00. *Assoc. of Mil. Surgeons, Washington, D. C.*

Mineral Industry, The—. *a.* **38.** $12.00. *McGraw-Hill Book Co., Inc., 370 Seventh Ave., N. Y. C.*

Mining Journal, The—. *w* 4 vols. **168.** £2. *15 George St., Mansion House, London, E. C. 4, England.*

Mining Magazine, The—. *m* 2 vols. **42.** $3.00. *The Mining Publications, Ltd., Salisbury House, London Wall, London, E. C. 2, England.*

Mississippi Educational Advance, The—. *m* (O–My). **20**(4). $1.50. *Miss. Education Assoc., Jackson, Miss.*

Monist. *q.* **40.** $4.00. *Open Court Pub. Co., 337 E. Chicago Ave., Chicago, Ill.*

National Education Association, Journal of the—. See **Journal of the,** etc.

National Education Association, Research Bulletin of the—. See **Research Bulletin of the,** etc.

National Geographic Magazine. *m* 2 vols. **57.** $3.50. *National Geographic Society, Sixteenth and M Sts., N. W., Washington, D. C.*

Nation, The—. *w* 2 vols. **130**(3365). $5.00. *20 Vesey St., N. Y. C.*

Nation's Schools, The—. *m* 2 vols. **5.** $2.00. *The Nation's Schools Pub. Co., 919 N. Michigan Ave., Chicago, Ill.*

Nature (London). *w* 2 vols. **125**(3140). £2 17s. *Macmillan and Co., Ltd., St. Martin's St., London, W. C. 2, England.*

Nature and Science Education Review. *q.* **2**(3). $1.00.* *American Nature Association, Washington, D. C.*

Naturwissenschaften, Die—. *w.* **18.** Rm9.60. *Julius Springer, Link-Str. 23–24, Berlin, W. 9, Germany.*

Naturwissenschaftliche Monatshefte für den biologischen, chemischen, geographischen und geologischen Unterricht. *irr.* **27.** Rm15. *B. G. Teubner, Poststr. 3, Leipzig, Germany.*

Nebraska Educational Journal. *m* (S–Jy). **10.** $2.00. *Nebraska Educational Journal, Lincoln, Neb.*

Neo-Chemto-Ion. (Mimeographed.) *K. M. Persing, Glenville High School, Cleveland, Ohio.*

Nevada Education Bulletin. *m* (S–Je). **12**(4). *Carson City, Nevada.*

New England Association of Chemistry Teachers, Report of the—. See **Report of the, etc.**

New Reclamation Era (formerly **Reclamation Record**). *m.* **21.** $0.75. *U. S. Bureau of Reclamation, Washington, D. C.*

New York State Education. *m* (S–Je). **17**(5). $3.00. *New York State Teachers' Assoc., Albany, N. Y.*

News Letter. *m.* **27**(3). $1.00. *Phila. Teachers' Assoc., 1522 Cherry St., Philadelphia, Penna.*

North American Review. *m* 2 vols. **229.** $4.00. *9 E. 37th St., N. Y. C.*

North Central Association Quarterly. *q.* **3**(3). $5.00.* *Room 4012. University High School Bldg., Univ. of Michigan, Ann Arbor, Mich.*

Nucleus, The—. *m* (O–Je). **7**(4). $1.00.* *A. A. Ashdown, Editor, Mass. Inst. of Technology, Cambridge, Mass.*

Nuovo cimento, Il—. *m* (O–Je). **7.** L100. *Nicola Lanichelli, Editor, Bologna, Italy.*

Ohio Teacher, The—. *m* (S–Je). **50**(5). $1.25. *Ohio Teacher Publishing Co., 50 W. Broad St., Columbus, Ohio.*

Oil and Gas Journal, The—. *w.* **28**(33). $6.00. *The Petroleum Publishing Co., 114–116 W. 2nd St., Tulsa, Okla.*

Oil, Paint and Drug Reporter. *w* 2 vols. **117.** $5.00. *Oil, Paint and Drug Reporter, Inc., 12 Gold St., N. Y. C.*

Oklahoma Teacher. *m* (S–My). **11**(5). $1.00. *C. M. Howell, Editor, Second and Broadway, Oklahoma City, Okla.*

Optical Society of America, Journal of the—. See **Journal of the, etc.**

Oregon Teachers' Monthly (discontinued May, 1929). *Teachers' Pub. Co., Salem, Ore.*

Outlook, The—. *w* 2 vols. **154.** $5.00. *The Outlook Co., 120 E. 16th St., N. Y. C.*

Pädagogische Warte. *sm.* **37.** Rm14.40. *A. W. Zickfeldt, Verlagsbuckhandlung, Osterwieck-Harz, Germany.*

Paper Trade Journal. *w* 2 vols. **90.** $4.00. *Lockwood Trade Journal Co., Inc., 10 E. 39th St., N. Y. C.*

Peabody Journal of Education. *bm.* **7**(4). $2.00. *George Peabody College for Teachers, Nashville, Tenn.*

Pennsylvania Gazette, The—. *bw.* **28.** *1625 Real Estate Trust Bldg., Philadelphia, Penna., Att. Mr. G. B. Hurff, Jr.*

Pennsylvania School Journal. 13 nos. per yr. **78**(5). $1.00. *400 N. Third St., Harrisburg, Penna.*

Pharmaceutical Era, The—. *m.* **67.** $2.00. *D. O. Haynes & Co., 154 Nassau St., N. Y. C.*

Pharmaceutical Journal and Pharmacist, The—. *w* 2 vols. £2 2s. *Pharmaceutical Society, 72 Great Russell St., London, W. C. 1, England.*

Phi Delta Kappan. *bm.* **12**(5). $1.50. *Paul M. Cook, Room 410, 1180 E. 63rd St., Chicago, Ill.*

Philosophical Magazine and Journal of Science, The London, Edinburgh and Dublin—. *m* 2 vols. **9**(53). 90s. *Taylor and Francis, Red Lion Court, Fleet St., London, E. C. 4, England.*

Physikalische Zeitschrift vereinigt mit dem Jahrbuch der Radioaktivitat und Electrotechnik. *sm.* **31.** $16.80. *S. Hirzel, Königstr. 2, Leipzig, Germany.*

Popular Science Monthly. *m.* **116.** $2.50. *Popular Science Pub. Co., Inc., 381 Fourth Ave., N. Y. C.*

Practical Home Economics (formerly **American Food Journal**). *m* 2 vols. **9.** $2.00. *468 Fourth Ave., Room 902, N. Y. C.*

Proceedings of the Indiana Academy of Science. *a.* **38**(1929). *State Librarian, Indianapolis, Indiana.*

Progressive Education. 8 nos, per yr. **7.** $3.00. *Progressive Educ. Assoc., 10 Jackson Pl., N. W., Washington, D. C.*

Przemsyl Chemiczny (formerly **Metan**). *m.* **14.** 36z. *Ul Leona Sapiehry 3, Lwow, Republic of Poland.*

Quarterly of the University of North Dakota. *q.* **20.** $3.00. *Univ. of North Dakota, Grand Forks, N. D.*

Ray of Gamma Sigma Epsilon, The—. 4 nos. per yr. **7.** $1.00. *A. P. Black, Dept. Chemistry, Univ. of Florida, Gainesville, Fla.*

Reclamation Record (now **New Reclamation Era,** which see).

Recueil des travaux chimiques des Pays-Bas. *m* (O–Jy). **49.** $6.60. *A. D. Donk, Secy., Dutch Chemical Society, 100 Verspronckweg, Haarlem, Holland.*

Report of the New England Association of Chemistry Teachers. *q.* **31**(3). $1.50. *New England Assoc. of Chem. Teachers, 102 Sumner St., Medford, Mass.*

Research Bulletin of the National Education Association. 5 nos. per yr. **8.** $1.00. *National Education Assoc., 1201 Sixteenth St., N. W., Washington, D. C.*

Review of Reviews. *m* 2 vols. **81**(480). $4.00. *55 Fifth Avenue, N. Y. C.*

Revue scientifique illustrée. *sm.* **68.** F85. *286 Blvd. St. Germain, Paris (VIIe), France.*

Review of Scientific Instruments, The—. (Formerly part of the **Journal of the Optical Society of America** and Review of Scientific Instruments.) *m.* **1.** $4.00.* *F. K. Richtmyer, Managing Editor, Cornell Univ., Ithaca, N. Y.*

Rice Institute Pamphlet. *q.* **17.** *Houston, Texas.*

Royal Dublin Society, The Scientific Proceedings of the—. See **Scientific Proceedings of the,** etc.

Royal Society of Arts, Journal of the—. See **Journal of the,** etc.

Rubber Age (N. Y.), The—. *sm* 2 vols. **26**(7). $2.00. *The Rubber Age, 250 W. 57th St., N. Y. C.*

Rubber Chemistry and Technology. *q.* **3.** $6.00.* *H. E. Simmons, Sec.-Treas. Rubber Division, Univ. of Akron, Akron, Ohio.*

School. *w.* **42.** $2.00. *The School News Co., 156 Fifth Ave., N. Y. C.*

School Executives Magazine, The—. (Formerly **American Educational Digest**). *m.* **50.** $3.00. *1126–28 Q Street, Lincoln, Neb.*

School Life. *m* (S–Je). $0.50. *Supt. of Documents, Govt. Printing Office, Washington, D. C.*

School Review, The—. *m* (S–Je). **38.** $2.50. *Dept. of Education, Univ. of Chicago, Chicago, Ill.*

School Science and Mathematics. *m* (O–Je). **30.** $2.50. *W. F. Roecker, 1439 Fourteenth St., Milwaukee, Wis.*

School & Society (now combined with **Educational Review**). *w* 2 vols. **31**(784). $5.00. *The Science Press, Grand Central Terminal, N. Y. C.*

Science. *w* 2 vols. **71**(1827). $6.00. *The Science Press, Grand Central Terminal, N. Y. C.*

Scientific American. *m* 2 vols. **142.** $4.00. *Scientific American Publishing Co., 24 West 40th St., N. Y. C.*

Science Classroom, The—. *m* (S–Je). $0.25. *Popular Science Publishing Co., 381 Fourth Ave., N. Y. C.*

Science Education (formerly **General Science Quarterly**, last issue published Mar., 1929). 4 nos. per yr. **14**(2). $1.50. *W. G. Whitman, Salem, Mass.*

Science & Invention (formerly **Electrical Experimenter**). *m.* **17**(9). $3.00. *Experimenter Publications, Inc., 381 Fourth Ave., N. Y. C.*

Scientific Monthly, The—. *m* 2 vols. **30** (172). $5.00. *The Science Press, Grand Central Terminal, N. Y. C.*

Science News-Letter. *w* 2 vols. **17**(456). $5.00. *21st and B Sts., N. W., Washington, D. C.*

Scientific Proceedings of the Royal Dublin Society, The—. *irr.* **20.** *Ballsbridge, Dublin, Ireland, or Williams and Norgate, 14 Henrietta St., Covent Garden, London, W. C. 2, England.*

Science Progress. *q* 2 vols. **25**(95). 31s 2d. *John & Murray, 50 Albemarle St., London, W. 1, England.*

Scribner's Magazine. *m* 2 vols. **87.** $4.00. *Charles Scribner's Sons, 597 Fifth Ave., N. Y. C.*

Sewage Works Journal. *q.* **2.** $3.00. *Wm. W. Buffum, 654 Madison Ave., N. Y. C.*

Sierra Educational News. *m* (S–Je). **26.** $2.00. *508 Sheldon Bldg., San Francisco, Calif.*

Sigma Xi Quarterly. *q.* $1.00. *Union College, Schenectady, N. Y.*

Silicate P's & Q's. *m.* **10.** Gratis. *Philadelphia Quartz Co., Philadelphia, Penna.*

Sitzungsberichte der preussischen Akademie der Wissenschaften. *irr.* Physik, Chemie, Mineralogie, etc., Klasse—Rm20. *Walter de Gruyter & Co., Berlin, W. 10, Germany.*

Society of Chemical Industry, Journal of—. See Journal of, etc.

Society of Dyers and Colourists, Journal of the—. See Journal of the, etc.

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